AN EVALUATION OF THE EFFECTIVENESS OF INTEGRATING AN SBAR COMMUNICATION TOOL IN A TEACHING HOSPITAL TO IMPROVE PATIENT SAFETY IN TAIWAN

by

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Abstract

For ensuring the patient safety without communication errors in hospitals, an effective communication skill within team members has been identified as a key point from literatures. It has also been proven in many occupational fields for crew members to effectively reduce the communication errors in their handoff. Situation-Background-Assessment-Recommendation (SBAR) is one of the most commonly used methods in the health care system. The health care system within a hospital is based on the teamwork provided by physicians, nurses, pharmacists, laboratory scientist, dietitians, and social workers etc… Not to be surprised, the caring quality of patient is the result of working effectiveness of team members and administrators. However, according to the statistic data shown, a lot of human errors happened during the handoff process especially in the field of communication within team members. Therefore the purpose of this study was to analyze the effectiveness of SBAR communication tool (the intervention) adapted in hospital handoff system. The effectiveness of the intervention was evaluated via the reported data (patient safety events, PSEs) to Taiwan Joint Commission on Hospital Accreditation (TJCHA). This data source was chosen as all PSEs that have occurred will be recorded by the TJCHA. A report (Taiwan Patient safety Report, TPSR) will be published annually after PSE have been gathered from participant hospitals nationwide. In this study, we used the quasi experimental design to eliminate the unknown background difference from control and experimental group via pre and post-tests. We also used pair t-test to

eliminate health care system change over time elapse.

The study period was from year 2006 to 2014, all the outcomes (or PSE), secondary data, obtained from TPSR were published by TJCHA annually. The intervention of this study adapted SBAR protocol to the handoff system in the experimental hospital from year 2010; meanwhile we observed the change of PSEs between control and experimental group. For the PSEs observation, we addressed them according to the TPSR classification. There are thirteen types of PSE to be classified as patient safety indicator (PSI) for the patient caring quality in a hospital. The injury degree in PSI are further classified by six levels such as death, extremely severe, severe, moderate, mild and no harm via severity assessment code (SAC) via root cause analysis (RCA). Two hospitals (the one named as control group without SBAR; the other one named as experimental group with SBAR intervention) conducted in this study were similar in hospital dimension, medical service, and employees. In the control group, there were 522 medical staffs including 114 clinicians and 310 nurses etc. to provide medical services. There were a total of 443 beds including 314 general beds and 129 special beds in this hospital. Seventeen specialties provided outpatient, inpatient, and emergency service which serviced a patient count of 514871, 11992, and 28325 patient/year respectively. In contrast to the control group, the experimental group adapted SBAR protocol since year 2010 and there were 543 staff providing medical services including 118 clinicians and 321 nurses etc. The experimental group owned 459 beds including 333 general beds and

126 special beds. Fifteen specialties provided outpatient, inpatient and emergency service which serviced a patient count of 445340, 10471, and 25733 patients/year respectively. We also used the nationwide data (TPSR dataset) to serve as a reference group for eliminating the bias from health management policy, health insurance payment, and hospital accreditation etc.

In the control group, the initial PSEs were 110 events in 2006, and by the end of 2014, the final PSE increased up to 305 events, approximately a three times increase comparing to the initial year. In the experimental group, the PSEs also showed an increase from 100 events to 130 events in year 2006 to 2014. In the reference group (TPSR system), the PSEs increased from 8,176 to 60,559 events since year 2006 to 2014. Regarding the effectiveness analysis of SBAR in handoff system, student t-test and general estimation equation (GEE) was used to analyze the pre (year 2009) and post-test (year 2010, 2012, 2014) of control and experimental group. In 2009 and 2010 year, no significant difference was shown between the experimental and control group. After the implementation of SBAR in three and five years later, the PSIs showed a significant difference between the two groups. The experimental group have a decrease of 9 and 14.58 PSEs comparing to the control group on year 2012 and 2014 respectively. If we look at the change in experimental group independently, we found a significant difference between year 2009 and 2014, where the PSEs in the experimental group was significantly increased ($p < 0.05$), meaning that the PSE increased over time. However, many causes such as policy requirement, hospital accreditation and health insurance payment can be the culprit of this increase than before. In contrast, the control group also showed a significant escalating trend over these years. However, via our analysis, the implementation of SBAR did effectively reduced the PSEs albeit the there was an increase in the total number of PSEs. The GEE test also showed the same results to the effectiveness by SBAR in the reduction of PSEs. Furthermore we analyzed the individual PSI affected by the intervention of SBAR. The results reveal the most effective reduction on PSEs were drug-related incidents (PSI 1), followed by falling incidents (PSI 2) and endo-tube incidents (PSI 9). If only communication error was placed into consideration, the endo-tube incidents and injurious behaviors were significantly reduced after year 2010. Lastly, we performed a study evaluating the harm level on patient injury by SAC. Compared to the control group, the experimental group showed that the injury degree induced by patient events falls mainly between the level of mild to moderate (lighter injury), occupying approximately 40% of the total events. Suggesting that through the intervention of SBAR tools, when events affect patient safety occurs, the harm level were limited and were not as evident Based on our results and finding, the intervention significantly improved the patient's health and safety, but more time is required to verify the time series effectiveness. Therefore, we suggest that SBAR can bring a better patient safety environment, but requires time to develop and adapt. The alteration in communication processes is a re-learning procedure and thus a continuous education as well as training courses provided to the staff is necessary in

the management of health care system. Introducing of SBAR to the handoff system is a critical and valuable method for improving patient's health care quality.

Keywords: SBAR, Patient Safety Event, Taiwan Patient Safety Report, Patient Safety Indicators, Handoff System

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1. Introduction

Hospital environments are commonly characterized by complicated care actions. For example, a patient admitted for brain tumor surgery will normally be transferred between numerous units (e.g., pre-surgery holding, surgery, post anesthesia care unit, and neurosurgery care unit) to receive care from a variety of healthcare professionals. In this disjointed environment, reduction of medical errors on behalf of healthcare providers is a critical factor to enhance patient safety and outcomes (IOM, 2004).

It is crucial for patients that their newest therapeutic information always goes with them while they are transferred from one caregiver to another. Unfortunately, that doesn't always happen. Patient handoff is a necessary procedure that serves as a messenger, passing on valuable information in-between various hospitals or within various departments. Busy health care professionals may sometimes neglect such important patient information during a shift change, the patient's chart may not have the newest recorded vitals of a patient, or caregivers may lack a clear understanding of the patient's care plan. As mentioned above, it is obvious why effective communication is necessary to provide patients a safe and healthy environment. Nonetheless, communication errors are still so common and patient safety during transfer in-between hospitals or departments are so vulnerable due to these communication errors (Li, 2009; Beach, 2003; Gandhi, 2005; Mukherjee, 2004; Sorokin, 2005).

According to the definition provided from the Joint Commission, handoff communication is "a real-time process of passing patient/client/resident-specific information from one caregiver to another or from one team of caregivers to another for the purpose of ensuring the continuity and safety of the patient/client/resident's care" (The Joint Commission, 2008). In fact, breakdowns in communication have been identified as a major cause of medical errors. According to the data provided by Joint Commission, 65 percent of sentinel events were primarily caused by errors in communication between 1995 and 2004. In 2005, an analysis by the commission determined that communication breakdowns led to 70 percent of sentinel events, with fully half of those occurring during handoffs.

To address these problems, the commission introduced a National Patient Safety Goal in 2006, requesting all hospitals to take a specific, consistent approach to handoffs of patients. For example, the Salem Hospital in Salem, Oregon, USA, began using crew resource management (CRM) techniques that were originally developed by NASA and later used throughout the airline industry. Through the CRM technique, all aspects of care delivery became standardized. In doing so, the implementation of CRM technique standardize the communication process, clearly define the responsibility of one caregiver to the next during a transfer procedure, it also provide a platform for interactive exchange of information between all concerned individuals. Caregivers must buildup enough trustwith the other caregivers involved in the transfer for the transfer procedure to be safe and efficient. In order to identify potential errors within the handoff process for both internal or external transitions, medical institutions must carefully review their current practices. For all that matters, the most important is to seek the best for the patient and to improve the safety of handoffs, patients should, whenever possible, be involved in the process because they can be strong advocates for their own interests.

The National Patient Safety Goals released in 2006 by the Joint Commission included the requirement that hospitals should use a standardized method of communication during handoffs, including giving all involved individuals a chance to ask and reply to questions. The goal does not specify, however, how organizations should accomplish this; each organization has to develop its own approach (Association of Perioperative Registered Nurses, 2010; Haig, 2006). Under this circumstance, the goal should be negotiable, acknowledging the need in-between various departments within the organizations. To fulfill the requirement, organizations must specify, communicate to the staff, and then utilize a protocol that leads to a consistent and well established communication system to pass on patient information. According to the commission, consistent implementation and use across the organization is provided via standardization and opportunities to educate the staff about the process. Again, the details of the process may vary somewhat from department to department, but the essential premise remains the same. It is also critical to review the effectiveness of this intervention once it is introduced into the system and address any issues that are identified. The Joint Commission, in its own documentation, has provided numerous details about what such a standardized approach should include (JCICP, 2005; DoD, 2005). Those details include the following elements:

- The situation of a given handoff
- Who is involved, or who should be involved, in a particular handoff communication
- Whether or not opportunities are provided for individuals involved in handoffs to pose and reply to questions
- An outline describing when to employ various communication techniques, such as the

SBAR technique or the repeat-back or read-back techniques

- What electronic or printed information should be made available during a given handoff

With all of the above in mind, in this study we sought to compare the specific effectiveness of the SBAR communication technique for handoffs in the hospital system in Taiwan.

1.1 Types of Handoffs in a hospital

In the past, the definition of "handoff" was ambiguous, and thus includes various forms of handoffs within the healthcare environment. In hospitals, such handoffs would typically include shift changes for nurses, physicians transferring on-call responsibility, physicians transferring responsibility for a patient, an anesthesiologist reporting to a post-anesthesia recovery room nurse after surgery, a nurse or physician transferring a patient from the emergency department to an inpatient unit, and temporary relief of coverage (e.g. to allow short breaks during shifts, when a team member is permanently or temporarily relieved from duty). A good handoff strategy is intended to enhance information exchange at key times such as transfers of care. More importantly, it maintains continuity of care in spite of changes in caregivers or patients. Handoffs can also include a transfer of knowledge and information about the degree of uncertainty (or certainty) about diagnoses, responses to treatment, recent changes in status and circumstances, and the overall care plan (including alternatives). In addition, responsibility and authority are also transferred. In conclusion, any lack of understanding for those in charge of care and decision-making may be a major contributor to iatrogenic errors, as identified in past root cause analyses of sentinel events and negative outcomes (Rockville, 2006).

Previous study has identified 10 barriers and 10 tips for an effective handoffs (Lee, 2008):

10 barriers to effective handoffs

- Insufficient education at medical and nursing schools
- A health care system that has historically supported individual performance and self-direction
- Insufficient engagement with patients and their families in the care process
- Staff resistance to change
- Insufficient time for doctors and nurses to provide for handoffs
- Background noise, interruptions, and other problems in the physical setting
- Language or other communication barriers between providers and the patient. Along these lines, it is important for clinicians to eschew ambiguous terminology
- Mechanical errors in communication, such as fax machines or e-mail problems or the inability to locate a patient record
- A lack of definitive medical research and data to determine acceptable handoff best practices
- Insufficient financial resources for the implementation of standardized handoff processes

10 tips for effective handoffs

- Make face-to-face handoffs whenever possible
- Ensure that both sides communicate during the handoff process
- Provide sufficient time for handoffs
- Use both written and verbal methods of communication
- When possible, conduct handoffs at the patient's bedside, and be sure to involve patients and families in the handoff. Provide clear information at the time of discharge
- Involve staff in the standards development for handoffs

- Incorporate various communication techniques, such as SBAR, in the handoff process, and require process to verify that information is both received and understood
- Besides an information exchange, handoffs should make clear the transfer of patient responsibilities from one provider to the next
- Use electronic medical record and other such technology, to streamline the exchange of accurate and timely information
- Seek feedback from staff, and be sure to check for use and effectiveness for the handoff

In hospitals, there are many types of handoffs, including the following:

1. Changes in nursing shifts
2. Physician transferring responsibility for a patient
3. Physician transferring on-call responsibilities
4. Relief of coverage on a temporary basis (as mentioned above)
5. An anesthesiologist reporting to a post-anesthesia recovery room nurse after surgery
6. Physician and nurse transferring a patient from the emergency department to an inpatient unit

A proper handoff should include all of the following components:

- Responsibility: During handoffs, it is the provider's responsibility to ensure that the recipient is aware of the responsibility passed on to them.
- Accountability: A provider remains accountable until both parties are aware of the responsibility that has been transferred.
- Uncertainty: When there is any uncertainty, the provider must clear up all ambiguities before the transfer is completed.

- Verbal communication: A provider should not assume that the person taking over the responsibility will read or understand written or non-verbal communications.
- Acknowledgment: Until it is has been acknowledged that a handoff is understood and accepted, a provider cannot relinquish responsibility.
- Opportunity: Handoffs are good opportunities to review and have the next provider assess the situation for both quality of care and safety (Rockville, 2006).
- Organizations must define, communicate to staff, and introduce a protocol that leads to a consistent and well established communication system to pass on of patient information, if they are to meet the Joint Commission requirements. According to the commission, standardization allows the organizations to raise an opportunity to educate staff about the process and to provide support to the consistent implementation as well as practice the approach across the organization.

1.2 Techniques and Tools to Aid in Handoffs

Various techniques and tools can aid in the handoff process and establish consistent communications. Institutions should use structured tools (e.g mnemonics, templates, or checklists) to ensure that no information is omitted during a handoff. These techniques can also help ensure the accuracy and timely exchange of information. Listed below are some common techniques that hospitals can adopt or adapt to benefit their organization's culture and needs. These techniques can be used in combination (Gurses, 2006; Lee, 2008).

1. Audiotapes: Audiotapes are a fairly typical method of sharing information during handoffs. They provide nurse and doctor a fast, effective way of communication, and they can be backed up by the use of a predetermined checklist. The clinician taking over can be provided with a detailed assessment from the former clinician through an audiotape. However, audiotapes do not, when used alone, meet the Joint Commission's National

Patient Safety Goals since those who are involved in the handoff was not given an opportunity to answer and ask questions. Ideally, the outgoing caregiver should stay on-site during the review of the audiotape to allow for a face-to-face discussion.

2. Checklists and forms: Checklists and similar forms is an alternative method for standardized and quick exchange of information. This process can be accelerated through information technology systems, such as electronic medical records. Checklists and other forms can be placed in the patient record. Paper forms can also be passed on physically from one caregiver to the next. When electronic forms are utilized, it is crucial to make sure that the information is received and reviewed, and again, it's very important to allow caregivers to ask questions and answer them.
3. The "Five Ps": Developed by Sentara Health Care in Norfolk, Va., the Five Ps streamline the transfer of responsibility among caregivers and also streamline patient information. The Five Ps are "Patient" (including name, identifiers, age, sex, and location), "Plan" (including diagnosis, treatment plan, and next steps), "Purpose" (which consists of providing a rationale for the care plan), "Problems" (which consists of explaining what's different or unusual about this specific patient), and "Precautions" (which consists of explaining what's expected to be different or unusual about the patient).
4. "I PASS the BATON": This mnemonic technique was recommended by the Department of Defense's Patient Safety Program as a way to provide optimal structure for improving communication during transitions in care (**Table 1**). The technique should include chances to confirm receipt, to ask questions, to clarify information, and to verify that the

information has been understood. This technique is designed to assist in both complicated and simple handoffs.

Table 1 Description of the "I PASS the BATON" technique

Symbol	Mean	Description
I	Introduction	Introduce yourself and your role/job (include the patient)
P	Patient	Name, age, sex, location, and other identifiers
A	Assessment	Current chief complaint, vital signs, symptoms, and diagnosis
S	Situation	Present condition and circumstances, including code status, level of certainty or uncertainty, and recent changes and responses to treatment
S	Safety Concerns	Critical lab reports and related values, socioeconomic factors, allergies and alerts, such as risk for falls and the like
the		
B	Background	Previous episodes, current medications, comorbidities, and family history
A	Actions	Detail what approaches to treatment were taken or are required and then provide a brief rationale for those actions
T	Timing	Explicit timing, prioritization of actions, and degree of urgency
O	Ownership	Who is responsible (nurse/doctor/team) at present? This includes patient and family responsibilities
N	Next	What will occur next? Are there any anticipated changes? Any contingency plans? What is the plan?

Ps: Source: Department of Defense Patient Safety Program, "Healthcare Communications Toolkit to Improve Transitions in Care," 2008

5. SBAR is a communications technique that was modeled on a process first used on nuclear submarines (**Table 2**). It helps ensure the consistent and concise exchange of information. Hospitals have been adopting SBAR to improve communication among clinicians, and it is also being adopted to standardize the informational exchanges during patient handoffs. SBAR is generally deemed suitable for simple handoffs, but some healthcare experts feel that SBAR does not delve deeply enough to provide the level of information needed

during a complicated handoff (Velji, 2008).

Table 2 Description of the SBAR technique

S	Situation	Patient's problem, diagnosis, treatment plan, wants, and needs
B	Background	Vital signs, list of medications, lab results, and mental and code status
A	Assessment	Current provider's assessment of the patient's condition
R	Recommendation	Recommend what needs to be done over the next few hours and beyond, and identify pending lab results

1.3 Introduction to SBAR and the Communication Techniques

Inadequate communication has been recognized as the most common cause of serious errors, both clinically and organizationally. There are several fundamental barriers to communication that exist across different disciplines and level of staff, including gender, hierarchy, ethnic background as well as differences in communication styles among disciplines and individuals. Where there are standard structures of communication in place promotion of communication between team members are more effective. The SBAR technique is one of them to standardize communication. It promotes patient safety by helping individuals to communicate with each other with a shared set of expectations. Nursing staff and physicians can use SBAR to share patient information within a concise and structured format, improving efficiency and accuracy. The SBAR technique was originally developed by the US Navy for use on nuclear submarines, and a company called "Safer Healthcare" introduced the technique into healthcare settings late in the 1990s as one aspect of its CRM training program. In the years since, SBAR has been adopted by healthcare facilities around the globe as a simple but effective way to standardize communications between caregivers (Cynthia, 2009).

1.4 Purpose of This Study and Research Questions

One major factor contributing to medical errors is communication failure among healthcare providers (Ayse & Yan, 2006). Transferring patients between hospital units for surgery or diagnostic tests is common in modern hospital settings. Communication breakdowns during transfers are a leading cause of discontinuity in care, which increases the likelihood of medical mishaps, failures to rescue, and increased complications. Research is thus required to help providers understand what information is communicated during patient handoffs. Accordingly, the purpose of this study is to evaluate the effectiveness of the SBAR communication tool as applied to patient handoffs in a hospital, and to analyze the latent effectiveness on patient safety after SBAR application.

Two primary questions will be addressed in this study: one target on patient safety issues that are caused by communication errors and the other target on improvements in the patient handoff system due to the effectiveness of SBAR.

1.5 Definitions of Terminology

1. Handoff: “The complete transfer of responsibility and care-giving activities from one provider to another, where the initial provider subsequently physically leaves the scene” (C.K. Christian, 2006).
2. Healthcare provider: a person who provides patient care, with a professional affiliation such as physician, nurse, social worker, physician assistant, nurse practitioner, or respiratory therapist.

3. Multi-professional: healthcare providers from multiple professions working together (including physicians, nurses, pharmacists, dieticians, infection control experts, social workers, respiratory therapists, case managers, lab worker, and service staff members).

2. Literature Review

For more than two decades, medical professionals have known that weak communication between healthcare providers influences patient care outcomes. As the healthcare environment has grown more complex, the sharing of patient clinical information among multiple providers has became more problematic. In numerous studies, communication issues among providers were shown to lead to increased medical error. This knowledge led researchers to focus on understanding how poor communication can induce medical errors and how better communication could potentially reduce the number of adverse events, improving patient outcomes.

The Harvard Medical Practice Study reported in the 1990s that undesirable events, such as medical errors, are often precipitated by complex interactions among a diverse group of caregivers, the patient and the patient's diagnosis (Leape, 1997). In response, Leape suggested avoid from blaming individuals to examine the contextual influences on error, including communication failures. Based on these recommendations, Wilson et al. (1995) examined the adverse events that occurred in 28 Australian hospitals and concluded that communication failures contributed to errors much more often than inadequate medical skills. A systematic approach also aided the Institute of Medicine's examination of the US healthcare environment and led to the recognition that a new healthcare delivery system that supported safe patient care was deeply required.

2.1 Collaboration and Communication in Hospital Settings

Numerous researchers (Larson, 1999; Mitchell, 2000; Bensing, 2005; Webster, 2012) have proposed that increasing collaboration among healthcare professionals would provide a solution to the above issues. Specific attention has frequently been focused on the quality of collaborations and communications between nurses and doctors (Vazirani, 2005; McCaffrey, 2011; Rothberg, 2012). Vazirani (2005) has observed that a collaborative working relationship is characterized not by subordination but by interdependence, and requires mutuality. Doctors and nurses, however, often have differing outlooks on the desirability or even existence of such relationships (Vazirani, 2005). The often differing views of these two professional groups reflect their historical roles and also the “disparities between physicians and nurses with regard to socioeconomic status, education, and socialization” (Larson, 1999). The historical roles of different types of healthcare providers are clear in Stein’s description of “the doctor-nurse game,” in which both doctors and nurses modify their communication behaviors with members of the other profession so that a hierarchical, power-based relationship was maintained (Flowerdew, 2012). Unfortunately, this way of communication is inefficient in that it actually requires both parties to use an indirect way of communication in order to gather the information necessary to plan and collaborate patient care (Baggs, 1988). While reviewing this issue, Stein et al. (1990) found that social developments and difference in the education and training of nurses and doctors has been influencing a shift from this hierarchical sort of model to one of collegiality and interdependence.

2.2 Healthcare Environments, Medical Mistakes, and Effective Communication

Recognition of these issues suggests that research was required to determine an efficient way for healthcare providers to exchange information and identify the factors for effective communication among providers (Manser, 2009). In addition, researchers began to see that communication in complex hospital environments consists of various frameworks; meaning, several synchronized and unsynchronized communication measures, devices and channels are used simultaneously by healthcare providers (Benham-Hutchins, 2010, Collins, 2011). Some of these communication methods, such as the telephone, have been noted as adding to complexity and disruption in the working environment by interrupting healthcare providers when they are working on another task (Wentworth, 2012). Uncertainty and time constraints add further to the complexity of healthcare environments and affect both the manners and methods used to pass along patient information. Leape et al. (1993, 1994) pointed out that, rather than blaming individuals, "preventing medical injury will require attention to the systemic causes and consequences of errors." In order to provide multi-professionals a platform to collaborate and communicate; reevaluation of current healthcare organization's structural and cultural support or constrain individual actions of various practitioner is necessary. Moreover, a systematic approach requires accepting the fact that humans make mistakes. While acknowledging the above, develops a system of safeguards and provide the necessary measures to identify, respond to, and prevent problems (Pham, 2012). Medical errors and communication challenges may include all of the following (Rockville, 2006):

- Language barriers: Particular challenges are posed by non-English speaking patients and/or staff
- Personalities: It is sometimes difficult to communicate with certain individuals
- Distractions: Emergencies can take a provider's attention away from the task at hand
- Conflict: Disagreements between individuals may disrupt the flow of information between them
- Workload: During times of heavy workloads, some necessary details may not be communicated, or they may be communicated but go unverified
- Shift changes: Communication breakdowns occur most often when transitions in care are made
- Various communication styles: Different types of healthcare workers have historically been trained with different communication styles
- Verification of information: It is critical to always verify and acknowledge the information exchanged. A retrospective study of adverse events by Horwitz et al. determined that omissions of information (for example, vital signs and medical history) were a factor commonly associated with adverse events (Horwitz L.I, et al., 2009).

2.3 Barriers in Patient Handoff Communication

The actual or perceived social status of healthcare providers and hierarchical environments may create barriers that interfere with coordination of care by determining who is eligible to raise issues or ask questions (Benham-Hutchins et al., 2010). A patient handoff such as one in which the "complete transfer of responsibility and care-giving activities from one provider to another, where the initial provider subsequently physically leaves the scene" has been identified as a process that is communication-dependent and particularly vulnerable to errors of omission (Foster & Manser, 2012). Those healthcare providers taking over the patient requires up-to-date information in order to make good decisions and provide excellent care. This requires information to flow freely between the healthcare providers transferring the patient and those taking over (Pham et al., 2012). Barriers to effective information transfers during handoffs include “the social setting, language barriers, medium of communication, time and convenience issues, and education issues” (Foster, 2012). Inadequate communication during handoffs may also result in increased medication errors, increased lengths of stay and unnecessary or redundant laboratory and diagnostic tests.

2.4 Patient Handoffs in Emergency Departments

Healthcare today occurs in an increasingly complicated clinical environment. Patients receive intervention from a variety of teams, each made of up multiple clinicians with different backgrounds, training, and expertise. Effective communications amongst these professionals is needed in order to provide high-quality, safe patient care within this environment. Breakdowns in communication have been described as preventable aspects of diagnostic errors and have been linked to delays in referrals and care as well as increase in mortality rates. Furthermore, experts estimate that failures in communication are the major factor in 60-70% of serious incidents. In a review of the reported adverse events that led to permanent disabilities in Australia, 11% were determined to be attributable to communication issues, a level almost double that attributed to inadequate skill levels among clinicians. Meanwhile, a review of major adverse events from 2005 to 2008 showed that communication problems were a significant contributor in 35% of cases. (The above mentioned data were extracted from the RiskMan (Runny, 2008; Finnigan, 2010) data collection, which depends upon voluntary reporting of adverse events.)

Poorly handled handoffs were identified by both ER physicians and hospital physicians as a major factor in adverse events (Apker J., 2007; Horwitz L.I., 2009). Horwitz et al found that 29% (n = 246) of the physicians surveyed reported experiencing an adverse event or near miss after emergency department transfers, and 36 specific mistakes were identified, including treatment errors (n = 14), disposition errors (n = 13), and diagnostic errors (n = 13) (Horwitz L.I., 2009). Failures in providing the latest vital signs during handoffs were cited in 10 of the 36 incidents, making them, the most prevalent cause of incidents. Information technology was also an issue in several errors, such as when vital signs recorded in the emergency department were not electronically visible. In another study, mishandled or delayed handoffs were reported to result in treatment delays. (Apker J., 2007). In particular, failures to communicate properly about pending tests and diagnostic results were a major cause of delay in care after a transfer. (Ong M.S., 2011).

2.5 Patient Handoffs in Operating Rooms

Wrong-site surgery rates are estimated to range from 0.09 to 4.5 per 10,000 surgical cases (Devine J. et al., 1976). The most common mistakes leading to wrong-site surgeries are failures to verify consent, scheduling errors, patient malpositioning, site-marking errors, lack of proper time-out, and surgeon decisions or technique issues in the operation room (OR) (Clarke J.R., 2007). A proper time-out involves verification of patient identity, procedure confirmation, and surgical site confirmation. In a systematic review, among the factors contributing to wrong-site surgery were increased age of the surgeon, multiple surgeons working on one case, multiple procedures being performed on one patient, emergency situations, and variant patient anatomy (Devine J. et al., 1976). Postoperative patient handovers are beset with potential technical and communication errors and may negatively impact patient safety. More than 40 million patients have surgery in the United States annually (Anesth A., 2012) and are subsequently transferred to a post-anesthesia care unit or intensive care unit (ICU) for recovery. According to an extensive review of the literature (Noa S. et al., 2012), these transfers are notable for poor teamwork and communication, patients arriving in a compromised state, lack of clarity in procedures, technical errors, lack of structure in processes, interruptions and distractions, lack of central information repositories, and nurse inattention due to multitasking. A correlation between poor quality handovers and adverse events has also been demonstrated, although causality has not been proven. Several advices and recommendataions were made to potentially improve the quality of postoperative handovers and the safety of patients during this critical period.

Commentators have made various recommendations for structuring the handoff process and for information transfer. Some of these recommendations are generally supported, including (1) the use of standardized processes (e.g., through the use of checklists and protocols); (2) ensuring the attention of all team members by completing urgent clinical tasks before the information transfer; (3) allowing only patient-specific discussions during verbal handovers; (4) requiring that all relevant team members be present and that each should have an opportunity to speak or ask questions; and (5) providing training in team skills and communication. Through investigations of surgical patient transfers, researchers have found that communication failures were distributed equally over all phases of surgical care: preoperative (38%), intra-operative (30%), and postoperative (32%), (Anwari J.S., 2002). Transfers in care and handoffs were particularly susceptible to communication errors, with 43% of communication failures occurring during handoffs and 39% occurring during intra-hospital transfers (Nagpal K., 2010; Smith A.F., 2008; Catchpole K.R., 2007). Surgical handoffs were again highlighted as being particularly poor in terms of communication (Anwari J.S. 2002; Nagpal K., 2010). The surgical team was frequently uninvolved in the handoff, and information on intra-operative events was typically conveyed by the anesthetic team, which could be unaware of surgery related issues (Nagpal K., 2010). Strategies to avoid surgical mistakes before they can occur include organizational interventions and policies such as having a standardized operating room layout, team stability to increase familiarity among team members, standardized procedures and checklists for critical tasks, clutter elimination, noise reduction, and short breaks to reduce fatigue (Wiegmann DA., et al. 2010). Additionally, various briefing tools can be used before the surgery begins to review names and roles of surgical team members, critical procedural steps, potential complications, and prophylactic measures. These tools enhance communication (Nundy S., et al. 2008) and have lessened hazardous events during surgery by 25% (Einav Y., et al. 2010).

2.6 Patient Handoffs in Intensive Care Units

Research into handoffs for patients being discharged from ICUs is still sparse. Most studies to date have focused on the physiological criteria that must be met before proceeding with a discharge. The Society of Critical Care Medicine, for example, has provided detailed discharge criteria to assist physicians in making discharge decisions (Society of Critical Care Medicine, 1999). However, the role of handoffs communication in this particular scenario is still poorly understood. Studies published to date have revealed a number of inter-professional communication barriers. For example, decisions are typically made by physicians and then communicated to senior staff members only (Watts R. et al., 2005). Tension between ICU team members and ward nurses has also been noted as a frequent issue. In a review of communication failures due to problems with ancillary staff availability, liaison issues, and poor communication in handoffs involving intra-hospital transfers from the ICU to other destination units, 31% of the incidents had significant adverse outcomes (Beckmann U., et al. 2004; Lovell M.A., 2001; Ong M.S., 2011). Other research has shown that using a specialized transport team for both inter- and intra-hospital transfers of critical care patients leads to a decrease in adverse events (Dunn M.J. et al., 2007.; Stearley H.E., 1998.; McGinn G.H. et al., 1996).

2.7 Application of SBAR in Patient Handoffs

Fortunately, the use of a structured methodology for communicating by using a standardized tool can improve the quality of the information exchanged. One such tool, SBAR, has been demonstrated to improve communication in various setting. The tool was developed by the US Navy to standardize urgent and critical communications in nuclear submarines. SBAR was also implemented in healthcare environments by a multidisciplinary team at Kaiser Permanente of Colorado and has since become a commonly used and effective tool, adapted for a wide variety of clinical scenarios in the USA. Because the SBAR format captures crucial information and streamlines communication, many organizations have found it to be useful for all sort of inter-staff communications, including physician to physician, physician to nurse or nurse to physician, and staff to physician. SBAR may also be used to give such information to care providers taking over during all types of handoffs, including referrals. In addition, there is a growing consensus among healthcare providers that SBAR's structure empowers staff, especially those who may feel timid when speaking to physicians or nurses, to communicate critical observations. The model serves as an effective tool to standardize communication, promote patient ownership and enhance provider empowerment. Although initially instituted for practitioners who are not doctors, many hospitals are now implementing SBAR for all healthcare providers.

In the past several years, resident duty-hour limitations have introduced a new component in patient care. Although studies have indicated an overall decrease in medical errors and enhanced quality of resident life since duty-hour limitations were imposed, preservation of continuity of care remains a major challenge. Implementation of the 80-hour work week has led to an increase in daily resident handoffs by 40% and created a system in which shift work and dependence on non-physician practitioners, including nurse practitioners and physician assistants, have become the norm. Studies have demonstrated that within this new paradigm of patient care, there has been an increase in preventable adverse events, longer lengths of patient stay, and an increase in laboratory study orders, all of which are attributable to errors in resident communication due to increased handoffs. A study by Williams et al. further identified that resident with such failures could be induced by decreased familiarity with patients among surgeons, distorted or inhibited communications, blurred boundaries of communication, and diverted surgeon attention. Using a system that instills a sense of patient ownership, a clear definition of roles and empowerment is crucial to promote patient safety and continuity of care. In the current study, we hypothesized that inclusion of a standardized resident handoff system into the surgical curriculum could minimize missed or misunderstood information, improving overall patient care outcomes. We chose SBAR as that system because it provides an excellent framework for communication, serving as an empowerment tool by allowing opportunities to ask questions, formulate a plan for care, and ensure that information was understood. Furthermore, SBAR is being implemented on an institution-wide basis, ensuring that communication standardization occurs among all healthcare providers (Cohen & Hilligoss, 2010). Handoffs encompass more than just the exchange of information; they involve a transfer of accountability and responsibility, as well as being a teaching opportunity ((Michelle A., Raduma T. et al., 2011).

2.8 Information Technology Applied in SBAR

The use of information technology provides a promising strategy for improving patient handoffs. Coupled with information from the given patient's electronic medical record (EMR), handoff tools can include automatic reminders, comprehensive presentations of patient history and data, increased patient information, and remote accessibility (Bernstein J.A. et al., 2010). When asked about the potential of various strategies, physicians ranked access to EMRs and close patient follow-ups as the strategies most likely to prevent diagnostic errors (Singh H., et al. 2010). By aggregating information specific to a patient and assisting in feedback, computer systems can lessen the cognitive burden of the health care provider, revamp patient follow-ups, and function as a safety backup (Schiff G.D. et al. 2010).

3. Conceptual Framework

The conceptual framework of this study is shown in **Figure 1**; the SBAR intervention was used in the handoff system of an experimental hospital since year 2010. The PSI data from TPSR was the observed outcome used in this study, generally this data represented all clinical units in a participant hospital reporting to TPSR dataset (no individual department data in TPSR dataset); we selected two hospitals with same scale to serve as a control group and an experimental group. A quasi experiential design (also **shown in Fig. 1**) was used in this study to eliminate errors/bias from the hospital itself and cross hospital difference. In Aim 1 to 4, we used student t test for comparing the difference between control and experimental group, and by student t test we avoid the difference in hospital characteristics. Regarding to Aim 5 to 7, the purpose was to eliminate the change in health policy, insurance payment, hospital accreditation over time (since year 2006 to 2014). The intervention of SBAR applied in the experimental group was initiated at January, 2010. Since this year the caregivers in the experimental group need to adapt the SBAR tool in patient handoffs and this action lasted for five years. Till the end of this study, this tool continued to play a role in patient handoffs in the experimental group. In contrast, the control group kept their previous handoff tool for patient care. The PSE data of control and experimental group retrieved from TPSR was compared in this study for verifying the effectiveness of SBAR intervention in handoffs.

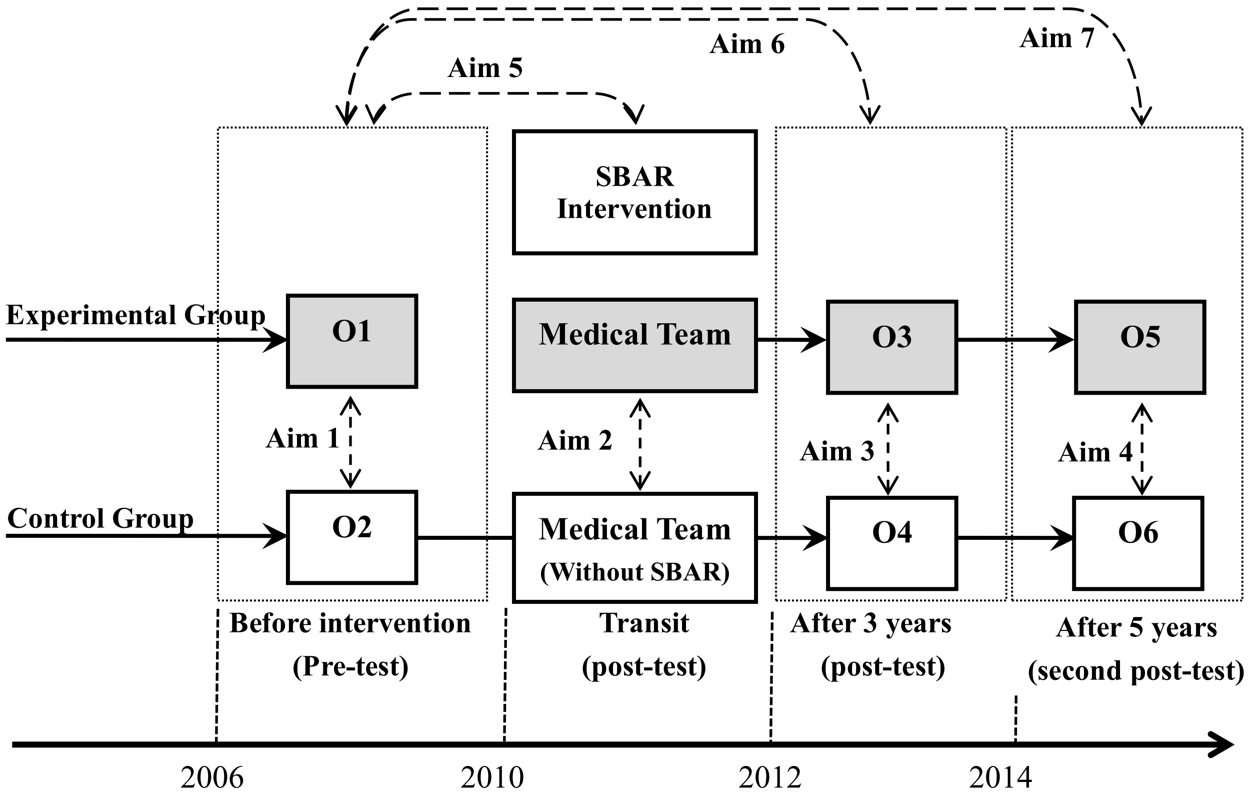

Figure 1 Diagram of the conceptual framework

3.1 Aim and Hypothesis

The aims and research hypotheses of this study were described as below:

1. **Aim 1:** To analyze the pre-performance differences between the experimental and control groups before the implementation of the SBAR communication tool in the handoff system.

   Research hypothesis 1: We hypothesized that no significant difference is present in patient care indicators between the traditional handoff system for the experimental and control groups.

2. **Aim 2:** To analyze the group performance differences immediately in the implementation of SBAR in the handoff system.

   Research hypothesis 2: We hypothesized a significant difference between the experimental group (with SBAR intervention) and the control group (without SBAR intervention) in patient care indicators.

3. **Aim 3:** To analyze the group performance differences immediately after three years of SBAR implementation in the handoff system.

   Research hypothesis 3: We hypothesized a significant difference between the experimental group (with SBAR intervention) and the control group (without SBAR intervention) in patient care indicators.

4. **Aim 4:** To analyze the group performance differences four months after five years of SBAR implementation in the handoff system.

   Research hypothesis 4: We hypothesized a significance difference between the experimental group (with SBAR intervention) and the control group (without SBAR

Intervention) in patient care indicators four months after five years of SBAR implementation.

5. **Aim 5:** To analyze the immediate performance difference in the same types of medical team with or without SBAR intervention in the handoff system.

   Research hypothesis 5: We hypothesized a significance difference for experimental group teams (with SBAR intervention) but not for control group teams (without SBAR intervention).

6. **Aim 6:** To analyze the long-term (3 years after) performance differences in the same types of medical team with or without SBAR intervention in the handoff system.

   Research hypothesis 6: We hypothesized a long-term significant difference for experimental group teams (with SBAR intervention) but not for control group teams (without SBAR intervention).

7. **Aim 7:** To analyze the long-term (5 years after) performance differences in the same types of medical team with or without SBAR intervention in the handoff system.

   Research hypothesis 7: We hypothesized a long-term significant difference for experimental group teams (with SBAR intervention) but not for control group teams (without SBAR intervention).

3.2 Process of SBAR implementation

In our study, we adapted second edition SBAR tool which was published from Toronto Rehab (Trentham, B. et al, 2010). **Table 3** shows the implementation stages of SBAR in the experimental group. Two basic stages (stage 1 and 2) named as education and implementation stage. The education stage lasted for four weeks, educating caregivers what is and how to use SBAR tool in their handoff, and during the period of SBAR implementation we continued to train the new and unfamiliar caregivers by the same course. After the education stage, we observed and screened the handoff's process, whether they followed the protocol in their handoff. If the expectations were not met, the training course was again given to those teams that didn't do well in handoff via administration order. This evaluation and education were performed once every half year. In the experimental group, under the committee of SBAR implementation, the education and evaluation work were carried out in each care-providing team member and support staff, ensuring the completeness of SBAR work. **Table 4** is the adapted and verified form of SBAR tool used in this study.

Table 3 Implementation stages of adapted SBAR

Weeks One & Two	Week Four	Ongoing over Two Months
Stage 1		**Stage 2**
Education Session #1 & #2	**Education Session #3**	**Implementation and Evaluation**
1. Education Session #1 Communication in Health Care and Using the SBAR Tool (didactic session) (suggested time: 1.5 hrs) (Education Session #1 Resources) 2. Education Session #2 Experiential-Based Learning with the Adapted SBAR Tool (practice session) (suggested time: 2.0 hrs) (Education Session #2 Resources) ** or combine Sessions #1 & #2 in a 2-hour session (Slides with Notes #1+2 condensed) 3. Participants begin to use SBAR	1. Education Session #3 SBAR Team Focus Group Discussion (suggested time: 1.0 hr) (Education Session #3 Resources) 2. Respond to any questions/difficulties expressed by participants in their initial experiences using SBAR 3. Seek feedback on ways to support implementation (e.g., signage, telephone prompts, team debriefings)	1. Monitor and evaluate implementation process using the forms provided (Stage II Resources) 2. Audit each participant approximately one month after Education Session #2 and again at the end of the implementation period (e.g., at six months) (Stage II Resources: “One-on-One Interview Questionnaire” and “Confidence and Implementation Tracking Form”) 3. Ongoing audit at rounds or team meetings (approximately every 2 weeks) to track usage, as well as enablers of and barriers to use. (Stage II Resources: “Team Rounds Tracking Form”) 4. Identify key champion(s) to encourage and reinforce team use of SBAR 5. Offer ongoing training of new staff, volunteers and students 6. Review participant feedback and evaluations 7. Revise implementation processes as needed

Table 4 The adapted SBAR checklist

S **Describe** **SITUATION**	Hello, my name is ... and I work in … (your service) I need to tell you about: ☐ An urgent health issue in regards to … (name of client) ☐ A quality of care issue in regards to… (name of client) I need approximately … (minutes) to speak with you. If now is not a good time, when can we talk? I need you to be aware of : ☐ Changes to the patient’s status ☐ Changes to the treatment plan, protocols or procedures ☐ Organizational/ environmental issues relevant to patient care
B **Provide** **BACKGROUND**	Are you aware of … (specific problem)? The patient is … (age) and has received a diagnosis of …. (diagnosis) and … (diagnosis) He/She was admitted on … (date) and is scheduled to be discharged on … (date) His/Her treatment plans in relation to this issue to date has include … (treatment) He/She is being overseen by … (specialist) and has appointments for … (procedures) This patient/family/staff is asking that … (requests)
A **Provide client** **ASSESSMENT**	I think the main underlying issue/concern is … (describe) The primary changes related to the specific concern since the last assessment : **Patient Level Changes** ☐ Vital Signs/GI/ Cardio-Respiratory ☐ Pain ☐ Musculoskeletal/Skin ☐ Neurological ☐ Sleep ☐ Psychosocial/Spiritual ☐ Medications ☐ Cognitive/Mental Status/ Behavioral ☐ Hydration/ Nutrition **Activity/Participation/Functional Changes** ☐ Transfers ☐ ADL ☐ Home/Community Safety Environmental Changes ☐ Organizational/Unit Protocols/ Processes ☐ Social/Family Supports ☐ Discharge Destination
R **Make** **RECOMMENDATION**	According to this assessment, I request that: ☐ we continue /discontinue … ☐ we prepare for patient discharge OR extend the patient’ s discharge date ☐ you approve the recommended changes to the treatment plan/goals including … ☐ you revisit and reassess the patient’ s … ☐ the following tests/evaluations be completed by … ☐ the patient be moved to …/transferred to … ☐ you inform other team members/the patient/ the patient’ s family about the change in plans ☐ We modify team protocols in the following ways … To be clear, we have decided to … Are you okay with this plan? ☐ I would like to hear from you again by … ☐ I will contact you about this issue by …

5. Materials and Methods

To analyze the effectiveness of SBAR, we used a quasi-experimentation design for systematically comparing the pre-and-post outcomes to SBAR intervention between an experimental group, a control group, and a reference group. The detail methodology of this study including measurement method, study design, hospital profile, data collection etc. is described as below.

4.1 Study Design

In this study, we used a quasi-experimental design to eliminate an unknown background difference from control and experimental group via pre and post-test. Before the intervention **(as phase one),** we pre-tested the events of patient safety between control and experimental group to eliminate the potential bias in this study by student t and GEE (Generalized Estimation Equation, GEE) test. We also used student t and GEE test to test the statistical significance between the control and experimental groups. After that, in the experimental group (as **phase two)**, we adapted the tool of SBAR in handoff and compare the ongoing difference in patient safety between those two groups. The pair t-test also was used to eliminate the change in hospital environments itself over the time elapse. Detail of our study design is described below.

1. Phase 1: Before the intervention of SBAR adaption

In the first phase (year 2006 to 2010), we gathered the information regarding the handoff that was used from each clinical department, and from these information, we made the standard SBAR format. We named this intervention as adaption SBAR in our study. Regarding the outcomes of the PSI data in the control, experimental and reference group, we indirectly retrieved them from the dataset of TPSR each year as these PSI data had been confirmed by hospital's administration and TPSR system. After care evaluation, there were no ambiguous dataset in this reported dataset.

2. Phase 2: To implement and evaluate adaption SBAR tool in the experimental group

During the year 2010 to 2014, it was the implementation phase of SBAR in the experimental hospital. In this phase, all full-time and part-time clinical and support staffs were required to use SBAR tool in their handoff work. We then observed and assured the SBAR tool were been performed correctly by reviewing their SBAR sheet or information in the experimental hospital. If the SBAR tool were not performed correctly by clinicians or team member, they will be re-educated and re-assured by their clinical or administration leader. For each clinical department, these works were reviewed by SBAR promote committee in the experimental hospital once every quarter. If the underperformance of SBAR implementation persists in the clinical department, they will be corrected by the researcher as soon as noted.

During the study period, we also selected a hospital with similar scale to serve as the control group; implementation of SBAR protocol in its handoff system to clinical caregivers was not done. Moreover, we like to know the PSI change of Taiwan's hospitals, so we selected the regional hospitals to serves as a reference group, and their data was calculated by average and acted as a reference data when we compared the trend of PSI between control and experimental group.

5.2 Profile of participating Hospitals

This study was conducted in two hospitals with similar scale located in Taipei city, Taiwan. We named the first hospital as "hospital A" and placed it as the experimental group in this study. Intervention of SBAR tool in its handoff system was introduced since year 2010. The detail profile of hospital A is listed in **Table 5a and 5b**. There was 543 staff providing medical services including 118 clinicians and 321 nurses etc. The experimental group owned 459 beds including 333 general beds and 126 special beds. Fifteen specialties provided outpatient, inpatient and emergency service which serviced a patient count of 445340, 10471, and 25733 patients/year respectively. In the experimental group, we adapted the intervention of SBAR protocol to replace its original handoff system since year 2010 compared the effectiveness before and after the intervention. In contrast to the experimental group, the control group had a similar scale in medical services as showed in **Table 5a and 5b.** In the control group, there were 522 medical staffs including 114 clinicians and 310 nurses etc. to provide medical services. There were a total of 443 beds including 314 general beds and 129 special beds in this hospital. Seventeen specialties provided outpatient, inpatient, and emergency service which serviced a patient count of 514871, 11992, and 28325 patient/year respectively. As shown above, both hospitals are similar in number of staffs, beds, departments, and patient load, the main difference being introduction of SBAR tool into the caregiver of the experimented group since year 2010. The patient safety events, between pre and post intervention of experimental and control group, were used as the indicator to verify change in care quality; they were also used to evaluate the effectiveness of SBAR protocol adapted in this study.

Table 5a Profiles of the participating units and hospitals

Characteristics	Control group	Experimental group	unit
hospital level	teaching and regional hospital		
hospital number	1	1	number
Handoff type	Traditional	before year 2010: traditional After year 2010: SBAR	N/A
Professional			
Clinicians	114	118	person
Nurses	310	321	person
Pharmacist	25	27	person
Examiner	26	26	person
Social worker	12	14	person
Others	35	37	person
Sub-total	522	543	person

The profile of control and experimental hospital collected from TPSR database in year 2015.

Table 5b Profiles of the participating units and hospitals

Characteristics	Control group	Experimental group	unit
Specialty number	17	15	number
Specialty	Department of Family Medicine, Department of Pediatrics, Department of Obstetrics and Gynecology, Department of Orthopedics, Department of Neurology, Department of Otolaryngology, Department of Ophthalmology, Department of Dermatology, Department of Psychiatry and Rehabilitation, Department of Anesthesiology, Department of Radiology oncology, Department of Anatomy and Pathology, Department of Emergency Medicine, Orthopedics, General Western medicine, General Department of Dentistry, General Department of Traditional Chinese Medicine	Department of Family Medicine, Department of Pediatrics, Department of Obstetrics and Gynecology, Department of Orthopedics, Department of Neurology, Department of Ophthalmology, Department of Dermatology and Psychiatry, Department of Radiology, Department of Anatomy and Pathology, Department of Clinical Pathology, Department of Emergency Medicine, Department of Orthopedics, General Surgery, Department of General Dentistry, General Department of Chinese Medicine	specialty
General Beds	314	333	beds
Special Beds	129	126	beds
Volume			
Outpatient	514,871	445,340	Num./year
Inpatients	11,992	10,471	Num./year
Emergency	28,325	25,733	Num./year
Average length of stay	10	12	Days/patient
Operation	5,186	4,788	Num./year
Occupancy rate (Beds)	73	67	%

The data of control and experimental hospital retrieved from TPSR database since year 2006 to 2014.

4.3 Data categories and collection steps

4.3.1 Category of patient safety indicators

The reason we retrieved PSI's data from TPSR dataset and used it as quality indicators for patient safety was because this is an official report send from hospitals to Taiwan Patient Safety Net (TPSN, ministry of health and welfare, Taiwan). These patient safety events dataset were then verified by ministry of health and welfare (MOHW), Taiwan and published annually. There are various indicators to evaluate the quality of patient safety in hospital management, and this data we used (published by TPSR), contains all iatrogenic and adverse events that had happened in the clinical units. Nearly all hospitals are required to report their PSEs annually according to the rule of MOHW, Taiwan. In this database, there are thirteen sets of PSI data that can be used as indicators for assessing patient safety in hospitals. Generally speaking, common incidents are categorized into medical error, medical adverse event, sentinel event and medication. Whereas domestic and international hospitals currently classify incident reporting contents into medical adverse event, sentinel event, near miss event, no harm event, and major event, the above events are defined as below.

1. Medical adverse event: Injuries are not resulted from the existing disease, but a patient being physically injured, extended stay in the hospital, or appearing certain degree of disability, or even death, caused by medical behaviors when leaving the hospital.
2. Sentinel event: It refers to the loss of permanent functions in an unexpected death and non-natural course of disease of a case, or the events of patient suicide, stealing infants, blood transfusion, and use of incompatible plasma components resulting in hemolysis, wrong recognition of patients or surgery parts, comorbidities during and after surgery, inadequate treatment, or giving a wrong baby to a family.
3. Near miss: Accidents, injuries, or diseases which are expected to happen but do not really occur because of accidental or immediate interference.
4. No harm event: Injuries are not occurred, but errors or incidents do have an impact to a patient.

Based on the event characteristics, Taiwan Joint Commission on Hospital Accreditation (TJCHA) classifies medical events into 13 subtypes. They are drug-related incidents, falling incidents, surgery-related incidents, blood transfusion incidents, medical procedure incidents, public accidents, law accidents, injurious behavior, endo-tube incidents, unexpected cardiopulmonary arrest, anesthesia incidents, laboratory incidents, and other incidents (**shown as Table 6**). These data are regularly published every year by MOHW, and the collected data is an indirect indicator to patient safety. We used this data to evaluate the effectiveness of SBAR intervention in the experimental hospital's handoff. The duration of PSI data collection was from year 2006 to 2014. As mentioned earlier, year 2006 to 2010 was the first phase, we observed the outcome of patient safety from TPSR database in the control and experimental group, both of them did not use SBAR protocol in their handoff system during this phase. The second phase was the intervention of SBAR in the experimental group since year 2010, the control group did not made any change in its handoff system. We then observe and analyzed the PSI change of control, experimental and reference group from TPSR database. Based on the TPSR's criteria, the intervention of SBAR was evaluated in this study.

Table 6 Type of patient safety indicator

Indicators	Description
PSI1	Drug-related incidents
PSI2	Falling incidents
PSI3	Surgery-related incidents
PSI4	Blood transfusion incidents
PSI5	Medical procedure incidents
PSI6	Public accidents
PSI7	Law accidents
PSI8	Injurious behavior
PSI9	Endo-tube incidents
PSI10	Unexpected cardiopulmonary arrest
PSI11	Anesthesia incidents
PSI12	Laboratory incidents
PSI13	Other incidents

4.3.2 Procedure to report PSIs in hospitals

When an incidental event took place in a hospital, the stepwise approach to report an emergent or major events are as follow:

(1) Emergent or major events:

Including sudden death or serious complication of patients resulted from medical treatment and administrative incidents resulting in serious results or requiring emergent processing. Reporting procedure: Immediately inform the Head of unit → Director of the department → Medical dispute team & Deputy Superintendent → Superintendent.

(2) General events:

Report to the head of unit and input records to patient safety event reporting system → Director of department → Deputy superintendent → Superintendent.

(3) Reporter:

The employee (or the concerned party) in the hospital is responsible for incident reporting; a third party is also responsible to made such report when discovering the incident.

(4) Reporting methods:

Enter the patient safety event reporting webpage from patient safety event reporting system to file the report. An incident reporter should fill in the columns to report detail about the event, event content, and immediate actions taken after the incident. The head of unit should then fill in the columns of measure or method to prevent such incident from recurring, possible action to be taken if such incident recurred, etc.

4.4 Definition of patient safety indicators

In a hospital setting, there are many types of medical adverse events and errors caused by units or employees. They are classified and defined differently, thus we here clarify the adverse events / errors influencing patient safety directly from medical process that we used in this thesis. According the definition of Taiwan Patient Safety Reporting system (TPSR), events affecting patient safety include sentinel event, accident, incident, medical adverse event, no harm event, preventable event, adverse drug event, high-alert drugs and adverse drug reaction. The errors include medical error, medication error, near miss, active error, and latent error. Based on the classification from TPSR, there are thirteen types of incidents to be discussed, they are drug-related incidents, falling incidents, endo-tube incidents, injurious behavior, medical procedure incidents, laboratory incidents, law accidents, surgery-related incidents, public accidents, unexpected cardiopulmonary arrest, blood transfusion incidents, anesthesia incidents, and other incidents. The definition of each is shown in **Table 7**; each incident contains six aspects, they are listed as below.

1. Basic information: Including the time and location of occurrence, person(s) affected, immediate response measures, degree of injury to patient (such as death, extremely severe, severe, moderate, mild, near miss, no harm, and cannot be determined).
2. Incident content: Which includes the thirteen types of incident, the content is listed in **Table 7**, describing the incident occurred, reaction/response after occurrence, hospital standard operation, reason for occurrence, incident description, and possible causes.
3. Medical treatment after incidents: Contains medications and treatments performed after

the incident (e.g bandages or ice applications, and diagnostic procedures such as X-rays).

4. Method to prevent this type of incidents from recurring: Contains suggested methods or measurements for avoiding future recurrence of such incident (e.g education and training lessons, a change in medical care model, administrative procedure revisions, or communication with patients).
5. Possibility of incident recurrence: The content should include predicted frequency, location, and severity of recurrence.
6. Basic information of reporter: This information should include identity (i.e. physician or nurse), years of experience in current position, and other basic profile in current report.

Table 7 Patient safety indicators from TPSR classification

Code	Adverse events	Content of notification form
PSI1	Drug-related incidents	Stage at which error occurred, drug dosage form, drug name, reason for occurrence
PSI2	Falling incidents	Number of falls during the most recent year, assisting equipment use at time of fall, activity or process during which incident occurred, reason for occurrence
PSI3	Surgery-related incidents	Stage at which error occurred, surgery type, reason for occurrence
PSI4	Blood transfusion incidents	Stage at which error occurred, blood transfusion reaction induced after the incident, reason for occurrence
PSI5	Medical procedure incidents	During what type of medical procedure did the incident occur? Was it an invasive procedure? Error type and reason for occurrence
PSI6	Public accidents	Accidents occurred in public area, e.g. Lobby, our record include event type (i.e. Fire, mass food poisoning inside hospital) and reason for occurrence (e.g. Equipment, apparatus, or environmental factors)
PSI7	Law accidents	Accidents concern about security events (e.g. thief stealing money from inpatient). Our record includes event type (e.g. theft, patient missing, infant stolen, threat, violence,

		harassment and aggression) and reason for occurrence
PSI8	Injurious behavior	Any behavior that results in a physical injury either to the patient or to another that is significant enough to warrant either medical treatment or diagnostic services
PSI9	Endo-tube incidents	State of patient when incident occurred (had patient received a sedative?), manner of tube loss, tube type, material used to attach tube and reason for occurrence
PSI10	Unexpected cardiopulmonary arrest	Chronic disease history, reason for first aid, any cardiopulmonary arrest, return of spontaneous circulation, ultimate state at time leaving hospital
PSI11	Anesthesia incidents	The abnormal events during anesthesia
PSI12	Laboratory incidents	The abnormal events during inspection or other pathological processes
PSI13	Other incidents	Description of the entire incident, possible cause of incident

Ps. the counting unit of PSI in TPSR system is the events not percentage, and the count period is from January to December for each year normally.

4.5 To determine the injury degree by root cause analysis (RCA)

In the TPSR system, the participant hospital not only reported their patient safety events but also presented the degree of injury caused by patient safety events directly or indirectly. Determination for the degree of injuries is a crucial problem in hospital. According to the rule of TPSR, the hospitals need to establish a root cause analysis (RCA) team for avoiding repetition of similar emergent or major incidents. The establishment of RCA team aims to formulate proper and specific improvement measures. This was achieved through knowledge and information exchange among cross-departmental members, stressing on the risks as well as drawbacks of operation process and system design, rather than personal responsibilities. In general, RCA members in Taiwan typically involves 10 supervisors, twice number of seed members plus an executive secretary to deal with case conditions in a medical institute with a hospital scale of 500-1000 beds. The initiation principle and timing of RCA team are introduced as below.

1. **Start principle**

- Medical Adverse Event - Injuries are not a result from the existing diseases, but physical injuries of patients, extension of stays, certain disability when leaving the hospital, and death caused by medical behaviors.
- Sentinel Event - Including unexpected death, permanent function loss in an unnatural process, patient committing suicide, babies being stolen, use of blood transfusion or incompatible plasma components resulting in hemolysis, misrecognition of patients or surgery site, co-morbidities during and after surgery, inadequate treatment, given wrong baby to the family.
- Analysis of incident severity and re-occurrence according to Severity Assessment Code (SAC, shown in **Table 8**). Events classified as SAC levels 1 and 2 are considered to make immediate improvement actions, while SAC levels 3 and 4 are continuously monitored.
- Judging with incident decision tree (IDT) to ensure the event caused by the system.
- In the circumstance of special events, deputy director of medical quality and patient safety management unit as well as the executive secretary of RCA team should report to and request for agreement from the superintendent and deputy superintendent, or head of department to start the root cause analysis.

Table 8 Severity assessment code (SAC)

Frequency	Injury degree					
	Death	Extremely severe	Severe	Moderate	Mild	No harm
Several weeks	1	1	2	3	3	4
Several times a year	1	1	2	3	4	4
Once every 1-2 years	1	2	2	3	4	4
Once every 2-5 years	1	2	3	4	4	4
More than 5 years	2	3	3	4	4	4

The definition for degree of injury in SAC table is described as below:

- Death: Resulting in the death of patient.
- Extremely severe: Causing permanent disability or dysfunction of a patient, such as physical disability and brain damage.
- Severe: Events resulting in patient injuries, which require additional visit, evaluation, and

observation as well as operation, hospitalization, or extending stays in the hospital (e.g bone fracture or pneumothorax).

- Moderate: Events resulting in patient injuries, which require additional visit, evaluation, observation, or processing (e.g measuring blood pressure, pulse, and blood sugar more than ordinal, X-ray, blood tests, urine analysis, wound dressing, stitching, hemostatic therapy, 1~2 dose of medication.)
- Mild: Events causing injuries, but do not need or require slight treatment, without additional care, such as red skin, scratch, and bruise.
- No harm: Events occurring on patients, butdid not result in any injuries.

2. **Start timing**

- Superintendent level, deputy director of medical quality and patient safety management, or executive secretary of RCA team, will select events with high severity, high frequency, or necessary for overall investigation for the root cause analysis and make improvement.
- When an event is confirmed to be assigned for RCA, director of medical quality and patient safety management unit would arrange an RCA team according to the event contents. The RCA team should interview the employee directly related to the event in the incident unit within 7 days after confirming the root cause, then observe the environment, equipment, document, and operation procedure for the analysis evidence.

4.6 Methods of statistical analysis

Descriptive and analytic statistics were computed with the use of SPSS (version 20.0, Chicago, USA) for Windows. The descriptive statistics include frequencies, percentages, and means (± standard deviation (SD)) for qualifying participant hospital, PSIs and healthcare outcomes. The overall aims of this analysis were to compare the quality of patient care (via patient safety indicators) in caregiver's handoffs before and after SBAR implementation. To aim 1 to 4, we first used a student t-test to compare the indicators of patient safety between experimental and control teams before adapting the SBAR tool in the handoff. To perform a student t-test, the null hypothesis, denoted by $H_{0,}$ is a statement about performing SBAR efficiently for caring patient safety. An alternative hypothesis (H_1) is a statement that is accepted if SBAR is inefficient and which indicates that the null hypothesis is false. Next, we used general estimation equation (GEE) to compare the quality of patient safety by time series in these timing. By application of GEE, we could analyze the effectiveness of SBAR on different running steps. For example, we can assess whether adapting SBAR into a hospital handoff enhances patient safety as well as its latent effects. The adverse events were retrieved from 2006 to 2014, and each incident was classified to one of the thirteen types of incidents, and we used these data to build our analysis model.

4.7 Introduction to SBAR's steps and examples

As health care has evolved and became more specialized, there are increased numbers of caregivers involved in the patient care. Patients have a greater chance to encounter more handoffs than in the simpler health care delivery system. Ineffective handoffs can contribute to gaps in patient care and breaches in patient safety, including medication errors, wrong-site surgery, and even patient deaths. Clinical environments are full of dynamic and complexity, presenting many challenges for effective communication among health care providers, patients, and families. Some nursing units may "transfer or discharge up to 40~70 percent of their patients every day, therefore the improvement of handoff system in hospital units is critical for patient safety. The Joint Commission's stated Situation, Background, Assessment and Recommendation (SBAR) technique has become the industry's best practice for standardized communication in healthcare; effortlessly structuring critical information primarily for spoken delivery. Regular use of SBAR is an important component of any health care organization, assisting caregivers to function as an effective team member while establishing a culture of quality, patient safety and high reliability. We describe the intervention of SBAR below:

- **First step:**

  Quickly organize the briefing information in your mind or on paper using the four elements (Situation, Background, Assessment and Recommendation) in sequence. Only the most relevant data is included, and everything irrelevant or of secondary importance is excluded.

- **Second step:**

  Present your briefing. Since team members can immediately recognize and understand the familiar, predictable SBAR format, the presentation will help them more efficiently and effectively address a situation or solve a problem.

- **Third step:**

  They may confirm, clarify or enhance what you've said, then work with you to take the required action.

Here are the examples of SBAR applied in hospital's OR, pre and post-anesthesia care unit (PACU), which are shown in **Table 9, 10 and 11**, respectively.

Table 9 Elements of the preoperative to intraoperative handoff communication

Situation

- Name of patient and date of birth
- Name of operative or invasive procedure to be performed including modifiers and site
- Pertinent documents are present and consistent

Background

- Elements of patient history pertinent to surgery
- Medical clearance
- Patient allergies and NPO status
- Patient's vital signs and pain level
- Medication profile and medications taken today
- Specific laboratory results
- Code status of patient

Assessment

- Patient's current level of understanding of the surgery
- Special patient needs or precautions
- Pertinent aspects of the patient's emotional and spiritual status
- Pertinent cultural implications
- Anesthesia requests

Recommendations

- State whether the patient has been seen preoperatively by the surgeon and anesthesia care provider
- Determine whether the patient is ready for surgery
- Allow an opportunity for preoperative and intraoperative staff members to ask questions or voice concerns

Table 10 Elements of the intraoperative to pre-anesthesia care unit (PACU) handoff communication

Situation

- Name of patient and date of birth
- Name of operative or invasive procedure
- Performed procedures including modifiers and site

Background

- Type of anesthesia administered and name of anesthesia care provider
- Intraoperative medications administered including dose and time
- IV fluids administered
- Estimated blood loss
- Pertinent information related to the surgical site such as dressings, tubes, drains, or packing
- Any significant OR events

Assessment

- Hemodynamic stability
- Airway and oxygenation status
- Thermal status (eg, presence of hypothermia or hyperthermia)
- Urine output
- Presence or absence of surgical complications
- Level of pain
- Method of pain management

Recommendations

- Ensure that immediate postoperative orders have been completed
- Discharge from the PACU when stable
- Allow opportunity for intraoperative and PACU staff members to ask questions or voice concerns

Table 11 Elements of the post-anesthesia care unit (PACU) to inpatient unit hand-off communication

Situation
● Name of patient and date of birth
● Name of operative or invasive procedure
● Performed including modifiers and site
Background
● Type of anesthesia administered and name of anesthesia care provider
● Medications administered in the OR and PACU including dose and time
● IV fluids administered in the OR and PACU
● Estimated blood loss
● Pertinent information related to the surgical site such as dressings, tubes, drains, or packing
● Any significant OR events
● Any significant PACT events
Assessment
● Hemodynamic stability
● Airway and oxygenation status
● Thermal status (eg, presence of hypothermia or hyperthermia)
● Urine output
● Presence or absence of surgical complications
● Level of pain
● Method of pain management
Recommendations
● Ensure that the orders given by PACU physician have been completed
● Ensure that the surgeon's plan of care has been implemented
● Identify patient's and family members' educational needs
● Provide discharge instructions
● Discharge after two hours or when stable
● Allow an opportunity for PACU and inpatient unit staff members to ask questions or voice concerns.

4.8 Limitations and strengths

We identified several limitations in this study and list them as below:

1. Few case studies: the data collection was limited by the number of sample hospitals, making it difficult to achieve a systematic sampling of Taiwan's hospitals. As such, the generalizability of the results remains limited to units and hospitals with the same attributes as those in our sample.
2. The measurement of patient safety reported in this study was showed to be a proxy measure only. While there was an increase in the reported number of incidents and near misses, the numbers from the study period were quite small and may not be significant.
3. The results may not be an absolute accurate reflection of actual incidents at individual medical organizations. Similarly, the number of incidents in the nationwide database was not exactly the same as the number of incidents at all participating hospitals. We assume that the reason for the discrepancy in numbers of incidents is due to under-reporting of hospital organizations.
4. The culprits for event of patient safety are not only limited by communication skill in the handoff system. Other factors such as medical technology, level of disease, caring quality etc. may also affect the safety of patient. Therefore in this study, we used a quasi-experimental design to avoid the error of design.

This study also had several strengths:

1. This is the first study of SBAR in Taiwan's hospital: The study has several important elements that have never been previously studied, including the use of the SBAR tool for studying the handoff effectiveness in hospitals, and the study of both the traditional and SBAR handoff approaches.
2. Significance: It is hoped that the study results will help the participating units to identify the problems in the handoff system and thereby lessen the frequency of mistakes and errors that might impinge on patient safety.
3. As part of the study, we found some barriers to effective team communications. In order to communicate more effectively and efficiently within and various teams, tools such as SBAR, call-out, check-back, and handoff were introduced. The end result of an improved communication allows a safer patient care environment.
4. The development of trust and shared thinking models has facilitated effective communication, enabling the teams to quickly adapt to change in situations. Communication is particularly important as healthcare environments become more complex (for example, in emergency situations). Effective communication provides necessary information to other team members and facilitates the continual updates about a team's shared thinking model and its engagement in other team's activities.

4.9 Privacy Protection

Human subject protection review and approval was obtained from the Institutional Review Board of Taipei City Hospital. All participants were provided with a study disclaimer form that incorporated all the basic elements of informed consent per regulatory guidelines. Participants' names were not collected, and all handoffs were identified by an anonymous code for reporting and analysis. In addition, no patient information was recorded in the observation period.

6. Results

5.1 Descriptive statistics of patient safety events

5.1.1 Annual reporting of patient safety events from TPSR system

According to the data collected from TPSR system (**figure 2**), there were 171 hospitals registered in TPSR system since 2006 to report their PSEs. The trend increased over years, till the end of year 2014, there were 664 hospitals included. The hospitals include medical center, teaching hospital, regional hospital, and others (including psychiatric hospital, nursing house and partial clinics). The analysis of reporting data from different hospital type is listed in **Table 12**. Here we can find the average of PSEs based on the scale of hospital. In medical centers the total average was more than metropolitan and regional hospitals every year since 2006. This is due to the hospital accreditation system in Taiwan; the most frequent indicator of hospital accreditation is patient safety, along with time, more events of patient safety incidents (PSI) were disclosed and reported. In hospitals reporting the issue of PSI, the environment become more transparent than ever; therefore the curve went up significantly. Till the end of 2014, the mean of PSI was 910, 318.9, 43.3 and 19 to medical center, metropolitan hospital, regional hospital, and others, respectively. Based on the dataset, the key point to prevent increase in PSI is to reduce the events in medical center or large hospital via education or training system for patient safety. The comparison between experimental group, control group and TPSR system is shown in **figure 3**. Here the annual data was chosen from the metropolitan hospitals database within the TPSR system (MTPSR) and compared to each other. The result showed that in the experimental group with SBAR handoff system, PSI was significantly reduced since 2010 when compared to the control group and MTPSR system. Additionally, the ratio of hospitals with SBAR handoff system had fifty percent more to implement in this year. The result suggests the effectiveness of SBAR handoff system was a key intervention for enhancing patient safety, and we found that the effectiveness was reinforced by the period of SBAR operation.

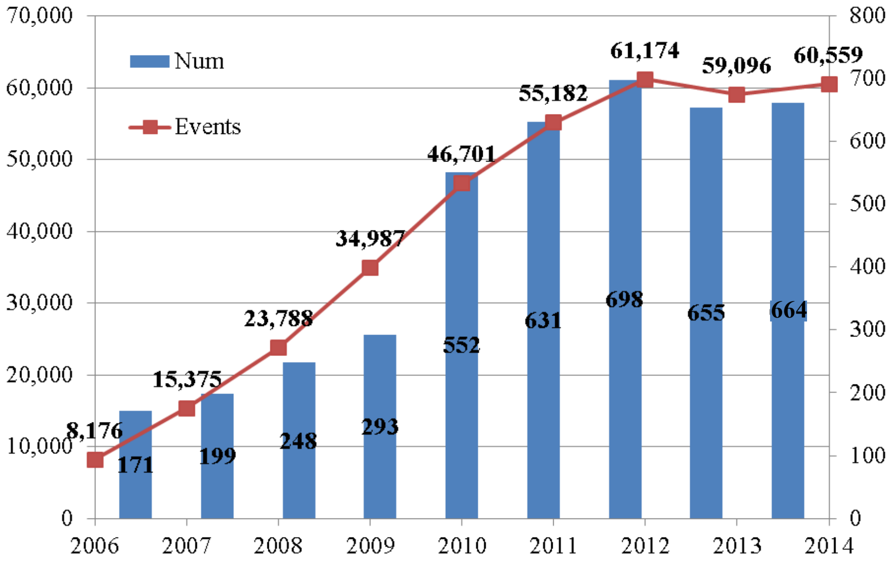

Figure 2 statistic data of patient safety events from TPSR system

Table 12 analysis of patient safety events from different hospital type

Year	Medical center			Metropolitan hospital			Regional hospital			Others			Total		
	Num	Events	mean	Num	Events	mean	Num	Events	mean	Num	Events	mean	Num	Events	mean
2006	9	1,394	155	44	4,679	106.3	101	1,745	17.3	17	358	21.1	171	8,176	48
2007	17	3,492	205	47	5,245	111.6	112	3,638	32.5	23	3000	130	199	15,375	77
2008	17	9,085	534	55	7,279	132.3	146	6,388	43.8	30	1036	34.5	248	23,788	96
2009	17	9,478	558	56	10,638	190	181	8,180	45.2	39	6691	172	293	34,987	119
2010	21	15,894	757	66	15,464	234.3	287	12,644	44.1	178	2699	15.2	552	46,701	85
2011	20	15,326	766	66	19,334	292.9	326	13,541	41.5	219	6981	31.9	631	55,182	87
2012	20	17,180	859	78	23,001	294.9	336	11,920	35.5	264	9073	34.4	698	61,174	88
2013	20	18,182	909	77	24,800	322.1	301	12,774	42.4	257	3340	13	655	59,096	90
2014	20	18,208	910	78	24,878	318.9	278	12,045	43.3	286	5428	19	662	60,559	91

Ps1. “num” is the hospital number

Ps2. “events” is defined from the table 11

Ps3. “mean” is equal to “events/num”

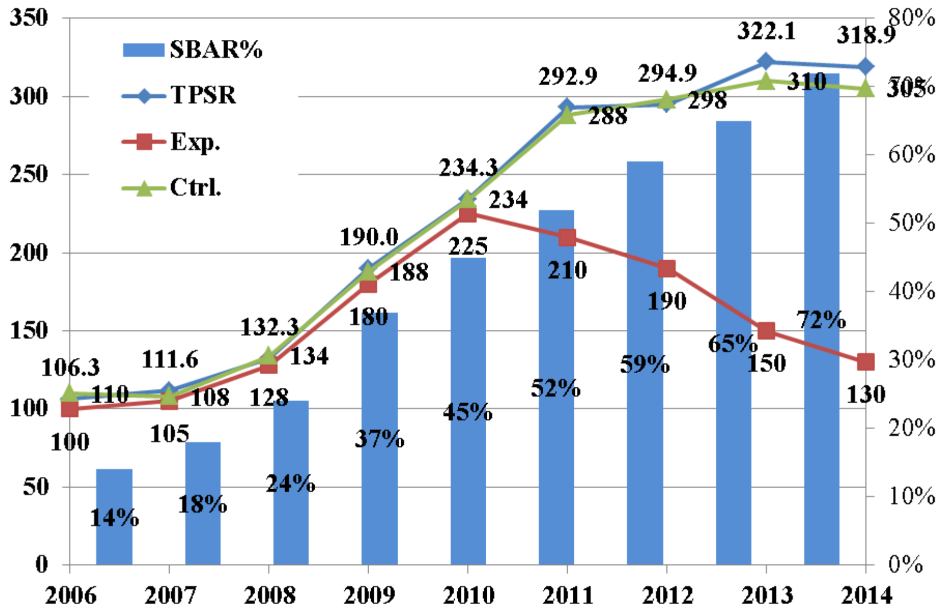

Figure 3 To compare annual data between hospitals

(Ps.SBAR% is the ratio of "hospital number with SBAR/total hospital" in the same hospital level)

5.1.2 The analysis of patient safety events in a hospital without SBAR implementation

The event analysis of PSI in control group (hospital B) is shown in **Table 13**. The number of events increased from 110 to 305 since year 2006 to 2014. We calculated the average number of PSI occurrence, which was also increasing, from the beginning on2006 being 9.2 events per month, to the end of 2014 being 25.4 events per month. This means that the events of patient safety in hospital did not slow down over the past nine years (2006 to 2014). It is a critical issue to prevent this kind of events to increase, as it putpatient safety at risk and injures caring quality. Therefore, to devise an effective action or policy in hospital to prevent growth of these events is important. Additionally, we looked into the percentage of TPSR report, where it showed a decrease from 1.35% to 0.5%. In the annual report, the total number of patient safety events from TPSR also had an increasing trend. The reported events of patient safety serve as the outcome of caring quality and the accreditation indicator of hospital. On average, there were approximately twenty events per month after 2010.

Table 13 the occurrence analysis of PSI in control group

Year / M(month)	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	5	6	11	8	13	31	20	26	29
2	11	6	17	10	16	16	23	23	31
3	6	17	10	11	22	33	24	25	20
4	7	5	18	16	24	13	49	9	21
5	15	7	12	16	13	16	25	24	31
6	10	3	4	16	25	17	31	20	26
7	13	12	14	14	13	33	19	28	20
8	11	4	8	18	24	20	24	28	32
9	12	8	18	23	16	24	23	25	27
10	9	14	8	16	28	22	22	29	22
11	7	11	9	22	22	20	21	24	24
12	4	15	5	18	18	43	17	49	22
Total	110	108	134	188	234	288	298	310	305
Mean (N/M)	9.2	9.0	11.2	15.7	19.5	24.0	24.8	25.8	25.4
std	3.41	4.65	4.78	4.48	5.30	9.08	8.38	8.99	4.52
% in TPSR	1.35%	0.70%	0.56%	0.54%	0.50%	0.52%	0.49%	0.52%	0.50%

Ps1. the calculation of “Mean” is the annual total PSI number divided by twelve months, e.g. 110/12=9.2 in year 2006

Ps2. The calculation of “%in TPSR” is the annual total PSI number in control group divided by the annual total PSI number in TPSR reporting system, e.g. 110/8176=13.5% in the year 2006

5.1.3 The analysis of patient safety events in a hospital with SBAR implementation

The event analysis of PSI in experimental group (hospital A) is shown in **Table 14**. The number of events increased from 100 to 130 since 2006 to 2014. Mean of PSI was 8.3 and 10.8 events per month for 2006 and 2014, which also showed an increasing trend if we only look at the beginning and the end. However, this increasing trend needs consist of two phase/components and need to be interpreted individually. The first phase was from the year 2006 to 2010, where the mean of PSI increased from 8.3 to 18.8 events per month. In the second phase (2010 to 2014), the PSI decreased from 18.8 to 10.8 events per month. In this group, intervention of SBAR protocol was used in handoff system by the medical team members since 2010. As mentioned above, the peak incident of patient events in this hospital took place in 2010, and showed a decreasing trend until the end of 2014. The percentage change of TPSR in this group decreased from 1.22% in 2006 to 0.48% in 2010 then to 0.21% in 2014. Just by looking at the change of percentage throughout the whole study period in this hospital, a biphasic change was not present, masking the effect of SBAR intervention in patient safety prevention. However, if this data was compared to the control group, a difference can be noted.

Table 14 the occurrence analysis of PSI in experimental group

Year / M(month)	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	12	8	10	18	22	8	19	17	5
2	9	10	8	12	16	18	20	9	9
3	6	11	16	19	13	22	9	15	4
4	9	9	9	10	18	27	14	7	11
5	9	7	9	18	23	21	18	11	17
6	9	9	16	16	20	17	13	16	11
7	7	10	9	15	23	16	15	8	7
8	8	8	14	16	20	11	12	9	14
9	7	11	8	12	25	22	11	16	11
10	8	8	10	10	18	13	22	8	14
11	8	7	9	12	7	11	21	16	7
12	8	7	10	22	20	24	16	18	20
Total	100	105	128	180	225	210	190	150	130
Mean (N/M)	8.3	8.8	10.7	15.0	18.8	17.5	15.8	12.5	10.8
std	1.50	1.48	2.93	3.84	4.96	5.90	4.20	4.17	4.82
% in TPSR	1.22%	0.68%	0.54%	0.51%	0.48%	0.38%	0.31%	0.25%	0.21%

Ps1. the calculation of "Mean" is the annual total PSI number divided by twelve months, e.g. 100/12=8.3 in the year 2006

Ps2. The calculation of "%in TPSR" is the annual total PSI number in experimental group divided by the annual total PSI number in TPSR reporting system, e.g. 100/8,176=1.22% in the year 2006

5.1.4 The analysis of patient safety events in the hospitals included in TPSR

The event analysis of PSI in reference group is shown in **Table 15**. The number of events increased from 8,176 in 2006 to 60,559 in 2014. We calculated the mean of PSI per month and an increasing trend was found from the beginning of 2006 (681.3 events per month) to the end of 2014 (5,046.6 events per month). Both the PSI and percentage change showed an liner increase from 2006 to 2014. This is associated with the increase in numbers of hospital reporting to TPSR, with 171 hospitals in 2006 and 664 hospitals in 2014. Additionally, the events per month increase from 47.81 in 2006 to 91.20 in 2014. The data reveals a relatively linear growth of patient safety events from 2006 to 2014, with a spike in 2009. The reason for this spike is unclear, however, the data clearly provides a platform for us to analyze the causes and injuries of the PSEs, and hopefully allow us to come up with a better method to prevent PSE.

Table 15 the occurrence analysis of PSI in reference group

Year / M(month)	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	624	1448	2284	2603	4165	4415	5661	4147	5155
2	730	1383	2199	3122	3924	4388	4742	5927	5316
3	693	1145	2096	2564	4064	4573	5761	5000	5089
4	709	936	3274	3714	3353	2878	5662	4112	4636
5	688	1396	2273	3239	3934	4848	4936	6385	6721
6	729	1482	1515	2816	4047	6250	4101	3843	5504
7	732	1178	1137	2805	3831	4304	5551	6076	3672
8	601	1232	2231	3586	4127	4562	4904	4151	4740
9	671	1387	1847	2624	4078	4860	4450	5076	3762
10	709	1061	2031	2528	3388	5471	5372	4924	4526
11	646	1093	1270	2850	3460	4281	4909	3974	4432
12	644	1634	1631	2536	4330	4352	5125	5481	7006
Total	8,176	15,375	23,788	34,987	46,701	55,182	61,174	59,096	60,559
Mean (N/M)	681.3	1281.3	1982.3	2915.6	3891.8	4598.5	5097.8	4924.7	5046.6
std	44.12	204.95	568.10	411.34	322.98	792.45	521.88	891.29	1017.54

Hospitals in TPSR	171	199	248	293	553	631	698	655	664
N/(h*M)	47.81	77.26	95.92	119.41	84.45	87.45	87.64	90.22	91.20

Ps1. the calculation of "Mean" is the annual total PSI number divided by twelve months, e.g. 8,176/12=681.3 in the year 2006
Ps2. The calculation of "N/(h*M)" is the annual total PSI number in TPSR system divided by the (hospitals in TPSR system* 12 months), e.g. 8,176/(171*12)=47.81 in the year 2006

5.2 To analyze the SBAR handoff system effect on hospital PSI

In this section, we discuss the effect of SBAR handoff system on hospital's patient safety. The experimental group operated SBAR protocol for handoff system since 2010, therefore, we chose 2009 as a reference/baseline for PSI analysis, year 2010, 2012 and 2014 served as the first, second and third post-test, respectively. The descriptive data is shown in **Table 16**, and pair t test was used as the statistic test to investigate the effectiveness of SBAR. The statistic test result is analyzed in the following section.

Table 16 The event analysis of PSI before and after SBAR implementation

Year / Month	Experimental				Control			
	2009 Pre	**2010 Post1**	**2012 Post2**	**2014 Post3**	**2009 Pre**	**2010 Post1**	**2012 Post2**	**2014 Post3**
1	18	22	19	5	8	13	20	29
2	12	16	20	9	10	16	23	31
3	19	13	9	4	11	22	24	20
4	10	18	14	11	16	24	49	21
5	18	23	18	17	16	13	25	31
6	16	20	13	11	16	25	31	26
7	15	23	15	7	14	13	19	20
8	16	20	12	14	18	24	24	32
9	12	25	11	11	23	16	23	27
10	10	18	22	14	16	28	22	22
11	12	7	21	7	22	22	21	24
12	22	20	16	20	18	18	17	22
Total	180	225	190	130	188	234	298	305
Mean	15.0	18.8	15.8	10.8	15.7	19.5	24.8	25.4
STD	3.84	4.96	4.20	4.82	4.48	5.30	8.38	4.52

Ps1. the calculation of "Mean" is the annual total PSI number divided by twelve months, e.g. 180/12=15.0 in the year 2009

6.1.1 To test the effectiveness of SBAR intervention with statistic on patient safety

Table 17 is the result of independent t test for testing the effectiveness of SBAR intervention in patient safety. Year 2009 was used as the baseline in the control and experimental group, comparing to year 2010 (the implementation year of SBAR used in handoff system), 2012 and 2014. When comparing 2009 to 2010, no significant difference was shown between experimental and control group (Aim 1 and 2), both groups showed no difference in the change of patient safety events by the mean of statistic analysis. After three and five years of SBAR implementation, we can find a significant difference between the experimental and control group. The experimental group had a decrease of 9 and 14.58 PSI events on 2012 and 2014 year (Aim 3 and 4) from the baseline, respectively. If we test the change of experimental group only (Aim 5-7), we found a significant difference between 2009 and 2014 (Aim 7), suggesting the disclosure of patient safety event is more effective in avoiding PSI. In contrast, the control group had a significant escalating trend (Aim 5A-7A) by years. Based on the statistic result, the implementation of SBAR in handoff system in hospital is an effective method to reduce patient safety events.

Table 17 The student t-test in handoff system with/without SBAR protocol applying

Year	Aim	Patient Safety Events (per year) Control group m/SD	Patient Safety Events (per year) Experimental group m/SD	t value	P value
2009	**Aim 1**	15.7/4.48	15.0/3.84	-0.392	0.699
2010	**Aim 2**	19.5/5.30	18.8/4.96	-0.358	0.724

2012	**Aim 3**	24.8/8.37	15.8/4.19	-3.328	0.003**
2014	**Aim 4**	25.4/4.52	10.8/4.82	-7.643	0.000**

**: P<0.05

Table 18 The test result for using SBAR protocol in handoff system by pair t test

Aim	Pair t test	Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Aim 5	E_2009 - E_2010	-3.750	5.610	1.620	-7.315	-.185	-2.315	11	.051
Aim 6	E_2009 - E_2012	-.833	6.464	1.866	-4.941	3.274	-.447	11	.664
Aim 7*	E_2009 - E_2014	4.167	5.524	1.595	.657	7.676	2.613	11	.024
Aim 5A*	C_2009 - C_2010	-3.833	5.952	1.718	-7.615	-.052	-2.231	11	.047
Aim 6A*	C_2009 - C_2012	-9.167	9.379	2.708	-15.126	-3.207	-3.386	11	.006
Aim 7A*	C_2009 - C_2014	-9.750	6.580	1.899	-13.931	-5.569	-5.133	11	.000

5.2.2 To estimate the trend of PSI by used with or without SBAR protocol in hospital

The generalized estimating equation (GEE) was used to test the timing effectiveness with or without SBAR handoff system; the results are shown in **Table 19-23**. The pre-test (2006-2010) is shown in **Table 19**; no significant difference existed in the control and experimental group. The absence of significant change in PSI could be explained by the fact that both groups didn't use the SBAR protocol in their handoff system during this period. After three years (2012) of SBAR intervention in the experimental group, the result of comparison is shown in **Table 20.** The PSI trend of control group is significantly higher than that of experimental group as shown by GEE test. We can also estimate the trend of PSI via **equation (1)** in both control and experimental group. The whole study period (2006 to 2014) was also tested with the results presented in **Table 21**; this result revealed the effectiveness of SBAR after five years of SBAR application. The trend of PSI in the experimental group was significantly lower than the control group, and the estimation can be calculated via **equation (2)**. The result suggests that application of SBAR protocol in a hospital's handoff system can significantly reduce PSI if SBAR protocol was previously not used. Additionally, we also compared the trend of PSI between the experimental and reference group (as shown in **Table 22**). The PSI data of the reference group was collected from nationwide; therefore allowing us to study the difference existing in the national PSI data. The result showed a significant change, and the trend of PSI can be calculated by **equation (3)** for reference and experimental group. **Table 23** is the comparison of control and reference group. The data of PSI in the reference group is collected from many hospitals' handoff system, with or without SBAR protocol. The trend of PSI in reference group showed absence of significant difference from the control group, suggesting that the tendency of reference (TPSR) and control group had no significant difference. In contrast, PSI trend of the experimental group is significantly lower than the reference group (TPSR), we can assume and suggest that this difference was due to the application of SBAR protocol in the experimental hospital.

Table 19 Parameter estimation of control and experimental group by GEE on pretest period (2006-2010)

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	50.369	2.5420	45.387	55.352	392.613	1	.000
[Group=0]	1.663	3.5950	-5.384	8.709	.214	1	.644[a]
[Group=1]	0	.	.	.	.	.	.
BaseLine	0						
Repeat	42.937	.9659	41.044	44.830	1976.176	1	.000
[Group=0] * Repeat	2.000	1.3660	-.677	4.677	2.144	1	.143[b]
[Group=1] * Repeat	0	.	.	.	.	.	.
(Scale)	101.031						

Dependent Variable: PSI

Group: control group=0; experimental group=1

Model: (Intercept), Group, Repeat(year 2007-2010), Group * Repeat

a. No significant difference between control and experimental group during year 2006 to 2010

b. No interaction between Group and Repeat

Table 20 Parameter estimation of experimental and control group by GEE (2006-2012)

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	121.879	6.5073	109.125	134.633	350.801	1	.000
[Group=0]	-48.012	9.2027	-66.049	-29.975	27.219	1	.000
[Group=1]	0[a]	.	.	.	.	.	.
BaseLine	0[a]	.	.	.	.	.	.
Repeat	17.349	1.7019	14.014	20.685	103.918	1	.000
[Group=0] * Repeat	20.680	2.4068	15.963	25.398	73.827	1	.000
[Group=1] * Repeat	0[a]	.	.	.	.	.	.
(Scale)	693.089						

Dependent Variable: PSI, Group: control group=0; experimental group=1

Model: (Intercept), Group, BaseLine(2006), Repeat(year 2007-2012), Group * Repeat

a. Set to zero because this parameter is redundant.

PSI = -121.88 – 48.0 * Group +17.35 * Repeat + 20.68 * Group * Repeat---------(1)

Table 21 Parameter estimation of experimental and control group by GEE (2006-2014)

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	152.480	9.8730	133.129	171.830	238.518	1	.000
[Group=0]	-48.910	13.9626	-76.276	-21.544	12.270	1	.000
[Group=1]	0[a]	.	.	.	.	.	.
BaseLine	0[a]	.	.	.	.	.	.
Repeat	3.578	2.3289	-.986	8.143	2.361	1	.124
[Group=0] * Repeat	25.282	3.2935	18.827	31.737	58.924	1	.000
[Group=1] * Repeat	0[a]	.	.	.	.	.	.
(Scale)	1579.319						

Dependent Variable: PSI, Group: control group=0; experimental group=1

Model: (Intercept), Group, BaseLine(2006), Repeat(year 2007-2014), Group * Repeat

a. Set to zero because this parameter is redundant.

PSI = 152.5 – 48.9 * Group-3.58 * Repeat + 25.3 * Group * Repeat---------(2)

Table 22 Parameter estimation of experimental and reference group by GEE (2006-2014)

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	152.480	9.8730	133.129	171.830	238.518	1	.000
[Group=0]	-48.910	13.9626	-76.276	-21.544	12.270	1	.000
[Group=1]	0[a]	.	.	.	.	.	.
BaseLine	0[a]	.	.	.	.	.	.
Repeat	3.578	2.3289	-.986	8.143	2.361	1	.124
[Group=0] * Repeat	25.282	3.2935	18.827	31.737	58.924	1	.000
[Group=1] * Repeat	0[a]	.	.	.	.	.	.
(Scale)	1579.319						

Dependent Variable: PSI, Group: reference group=0; experimental group=1

Model: (Intercept), Group, BaseLine(2006), Repeat(year 2007-2014),, Group * Repeat

a. Set to zero because this parameter is redundant.

PSI = 152.5 – 48.9 *Group -3.58 * Repeat + 25.28 * Group * Repeat-----------(3)

Table 23 Parameter estimation of control and reference group by GEE (2006-2014)

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test		
			Lower	Upper	Wald Chi-Square	df	Sig.
(Intercept)	79.868	181.1395	-275.159	434.895	.194	1	.659
[Group=0]	8842.930	13282.4623	-17190.217	34876.078	.443	1	.506
[Group=1]	0[a]	.	.	.	.	.	.
BaseLine	0[a]	.	.	.	.	.	.
Repeat	28.143	.0000	28.143	28.143	.	1	.000
[Group=0] * Repeat	6426.714	.0000	6426.714	6426.714	.	1	.000
[Group=1] * Repeat	0[a]	.	.	.	.	.	.
(Scale)	49587307.253						

Dependent Variable: PSI

Group: reference group=0; control group=1

Model: (Intercept), Group, BaseLine(2006), Repeat(year 2007-2014),, Group * Repeat

a. Set to zero because this parameter is redundant.

6.3 To analyze the thirteen indicators of patient safety effected by used with or without SBAR protocol

In this section we evaluate the effectiveness of SBAR handoff system in hospitalusing the thirteen indicators (PSI) as mentioned earlier. The tested groups include the control group (without SBAR intervention), experimental group (with SBAR intervention) and the TPSR reference group (with and without SBAR intervention), the results of SBAR intervention in these groups is presented below.

6.3.1 Analysis of the thirteen PSIs

The thirteen patient safety indicators in hospital without SBAR implementation are listed in **Table 23** by total number of incidents and its percentage of total incident in each year. The top three PSIs are the drug-related incidents (PSI 1), falling incidents (PSI 2) and endo-tube incidents (PSI 9). These three indicators are also the one causing most of the patient safety events in hospitals generally, additionally, they commonly induce patient injuries and complications. The data reveals that the ratio did not change a lot, but the case number is rapidly increased by years. Before 2010, the reporting number is low, this could be due to two reasons, the first beign that PSI 5 and PSI 7 were not included in the index of patient safety in hospital before 2010. The second is due to the change in environmental setting, where incidents in hospital related to patient safety is required reported. Therefore as the years increased, the total PSI showed an increasing trend from 110 incidents in 2006 to 305 incidents in 2014 in the control group.

Table 24 The trend of PSI to a hospital without SBAR hand-off system

Ctrl. group		Years								
Items	Incidents	2006	2007	2008	2009	2010	2011	2012	2013	2014
PSI1	Drug-related incidents	26	34	42	50	68	84	95	98	93
		23.64%	31.48%	31.34%	26.60%	29.06%	29.17%	31.88%	31.61%	30.49%
PSI2	Falling incidents	20	20	38	48	58	44	71	58	60
		18.18%	18.52%	28.36%	25.53%	24.79%	15.28%	23.83%	18.71%	19.67%
PSI3	Surgery-related incidents	6	4	4	8	11	11	0	4	8
		5.45%	3.70%	2.99%	4.26%	4.70%	3.82%	0.00%	1.29%	2.62%
PSI4	Blood transfusion incidents	5	4	4	8	5	11	9	6	9
		4.55%	3.70%	2.99%	4.26%	2.14%	3.82%	3.02%	1.94%	2.95%
PSI5	Medical procedure incidents	0	0	0	0	0	5	2	4	5
		0.00%	0.00%	0.00%	0.00%	0.00%	1.74%	0.67%	1.29%	1.64%
PSI6	Public accidents	6	4	1	4	5	10	6	12	7
		5.45%	3.70%	0.75%	2.13%	2.14%	3.47%	2.01%	3.87%	2.30%
PSI7	Law accidents	0	0	0	0	0	8	3	4	12
		0.00%	0.00%	0.00%	0.00%	0.00%	2.78%	1.01%	1.29%	3.93%
PSI8	Injurious behavior	10	10	10	15	22	20	30	29	21
		9.09%	9.26%	7.46%	7.98%	9.40%	6.94%	10.07%	9.35%	6.89%
PSI9	Endo-tube incidents	16	15	12	25	28	46	44	39	41
		14.55%	13.89%	8.96%	13.30%	11.97%	15.97%	14.77%	12.58%	13.44%
PSI10	Unexpected cardiopulmonary arrest	6	4	5	8	11	10	7	8	12
		5.45%	3.70%	3.73%	4.26%	4.70%	3.47%	2.35%	2.58%	3.93%
PSI11	Anesthesia incidents	4	2	3	7	7	11	6	14	8
		3.64%	1.85%	2.24%	3.72%	2.99%	3.82%	2.01%	4.52%	2.62%
PSI12	Laboratory incidents	7	7	9	7	12	20	18	21	21
		6.36%	6.48%	6.72%	3.72%	5.13%	6.94%	6.04%	6.77%	6.89%
PSI13	Other incidents	4	4	6	8	7	8	7	13	8
		4%	4%	4%	4%	3%	3%	2%	4%	3%
Total		**110**	**108**	**134**	**188**	**234**	**288**	**298**	**310**	**305**
		100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Ps. the calculation of "%" is the annual total PSI number divided by each PSI's number, e.g. 26/110=23.64% in the year 2006

Table 25 is the data of PSIs distribution in the experimental group. The table reveals the top three indicators are the drug-related incidents (PSI 1), falling incidents (PSI 2) and endo-tube incidents (PSI 9). Something worth mention in this data is the indicators of public accidents (PSI 6), anesthesia incidents (PSI 11) and laboratory incidents (PSI 12). The above mentioned three indicators showed a gradual increase disregarding intervention of SBAR protocol in their handoff system for medical team, there were an increase in total PSI number, approximately by 30% when using 2006 as the baseline. As previously described, the law accident (PSI 7) was not included in the index before year 2010, thus no data is available.

Table 25 The trend of PSI to a hospital with SBAR hand-off system

Exp. group		Years								
Items	**Incidents**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
PSI1	Drug-related incidents	53	46	66	98	115	102	92	57	50
		53.00%	43.81%	51.56%	54.44%	51.11%	48.57%	48.42%	38.00%	38.46%
PSI2	Falling incidents	7	10	8	13	19	4	5	5	14
		7.00%	9.52%	6.25%	7.22%	8.44%	1.90%	2.63%	3.33%	10.77%
PSI3	Surgery-related incidents	1	2	4	3	6	10	7	6	6
		1.00%	1.90%	3.13%	1.67%	2.67%	4.76%	3.68%	4.00%	4.62%
PSI4	Blood transfusion	3	2	4	2	6	8	8	13	4
		3.00%	1.90%	3.13%	1.11%	2.67%	3.81%	4.21%	8.67%	3.08%
PSI5	Medical procedure incidents	2	2	2	2	2	5	5	2	2
		2.00%	1.90%	1.56%	1.11%	0.89%	2.38%	2.63%	1.33%	1.54%
PSI6	Public accidents	1	2	3	5	7	8	10	6	8
		1.00%	1.90%	2.34%	2.78%	3.11%	3.81%	5.26%	4.00%	6.15%
PSI7	Law accidents	0	0	0	0	0	10	8	4	3
		0.00%	0.00%	0.00%	0.00%	0.00%	4.76%	4.21%	2.67%	2.31%
PSI8	Injurious behavior	6	6	8	12	12	6	7	8	6
		6.00%	5.71%	6.25%	6.67%	5.33%	2.86%	3.68%	5.33%	4.62%
PSI9	Endo-tube incidents	18	19	18	27	30	15	14	10	8
		18.00%	18.10%	14.06%	15.00%	13.33%	7.14%	7.37%	6.67%	6.15%
PSI10	Unexpected cardiopulmonary arrest	0	6	2	1	6	10	10	11	6
		0.00%	5.71%	1.56%	0.56%	2.67%	4.76%	5.26%	7.33%	4.62%
PSI11	Anesthesia incidents	1	1	2	2	8	11	7	9	8
		1.00%	0.95%	1.56%	1.11%	3.56%	5.24%	3.68%	6.00%	6.15%
PSI12	Laboratory incidents	8	7	6	11	9	9	8	11	8
		8.00%	6.67%	4.69%	6.11%	4.00%	4.29%	4.21%	7.33%	6.15%
PSI13	Other incidents	0	2	5	4	5	12	9	8	7
		0%	2%	4%	2%	2%	6%	5%	5%	5%
Total		**100**	**105**	**128**	**180**	**225**	**210**	**190**	**150**	**130**

Ps. the calculation of "%" is the annual total PSI number divided by each PSI's number, e.g. 53/100=53.0% in the year 2006

In this study, we also collected data from TPSR system for investigating the difference between control, experimental and TPSR reference group. The result of TPSR is presented in **Table 26,** with the top three indicators of PSI being the drug-related incidents (PSI1), falling incidents (PSI2), and endo-tube incidents (PSI 9). This ranking is the same as that of the control and experimental group. Here we pointed out two interesting trends worth further discussion. The first one is the injurious behavior (PSI 8) showing a declining trend in ratio with an increase in total number of events. Injurious behavior was defined to include any behavior that results in a physical injury either to the patient or to another that is significant enough to warrant either medical treatment or diagnostic services. The second one is the laboratory incidents (PSI 12), both the ratio and the total number of event showed an increasing trend; we define the laboratory incidents that included abnormal events during inspection or other pathological processes. Additionally, the total amount of all indicators in 2014 was 7.4 times more than that of 2006; this could be explained by the increase in the number of hospitals reporting to the TPSR.

Table 26 the trend of PSI from TPSR system

TPSR group		Years								
Items	**Incidents**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
PSI1	Drug-related incidents	937	1339	3641	4793	8158	9201	12639	12493	13196
		11.46%	8.71%	15.31%	13.70%	17.47%	16.67%	20.66%	21.14%	21.79%
PSI2	Falling incidents	1398	2274	2929	5119	6734	8635	9412	11093	12330
		17.10%	14.79%	12.31%	14.63%	14.42%	15.65%	15.39%	18.77%	20.36%
PSI3	Surgery-related incidents	406	1104	1476	2147	2344	2526	2953	2092	2309
		4.97%	7.18%	6.20%	6.14%	5.02%	4.58%	4.83%	3.54%	3.81%
PSI4	Blood transfusion incidents	460	758	1311	2053	2273	2582	2711	2107	2001
		5.63%	4.93%	5.51%	5.87%	4.87%	4.68%	4.43%	3.57%	3.30%
PSI5	Medical procedure incidents	682	1458	1851	1121	1559	1540	1971	1943	1922
		8.34%	9.48%	7.78%	3.20%	3.34%	2.79%	3.22%	3.29%	3.17%
PSI6	Public accidents	406	785	1304	2061	2216	2638	2757	2268	2254
		4.97%	5.11%	5.48%	5.89%	4.75%	4.78%	4.51%	3.84%	3.72%
PSI7	Law accidents	368	702	907	1385	1861	2695	2330	1991	2076
		4.50%	4.57%	3.81%	3.96%	3.98%	4.88%	3.81%	3.37%	3.43%
PSI8	Injurious behavior	934	1434	1668	2342	3219	3741	4182	4012	3782
		11.42%	9.33%	7.01%	6.69%	6.89%	6.78%	6.84%	6.79%	6.25%
PSI9	Endo-tube incidents	990	2525	3767	5479	8139	9236	9160	9900	9610
		12.11%	16.42%	15.84%	15.66%	17.43%	16.74%	14.97%	16.75%	15.87%
PSI10	Unexpected cardiopulmonary arrest	447	803	1228	2243	2355	2617	2879	2117	2269
		5.47%	5.22%	5.16%	6.41%	5.04%	4.74%	4.71%	3.58%	3.75%
PSI11	Anesthesia incidents	491	716	1445	2073	2242	2733	3084	2227	2150
		6.01%	4.66%	6.07%	5.93%	4.80%	4.95%	5.04%	3.77%	3.55%
PSI12	Laboratory incidents	219	747	960	2177	3370	4016	4301	4713	4464
		2.68%	4.86%	4.04%	6.22%	7.22%	7.28%	7.03%	7.98%	7.37%
PSI13	Other incidents	438	730	1301	1994	2231	3022	2795	2140	2196
		5%	5%	5%	6%	5%	5%	5%	4%	4%
Total		**8176**	**15375**	**23788**	**34987**	**46701**	**55182**	**61174**	**59096**	**60559**
		100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Ps. the calculation of “%” is the annual total PSI number divided by each PSI’s number, e.g. 937/8,176=11.46% in the year 2006

6.3.2 Comparison of the change in PSI with and without SBAR interevention

Wepresent the data collected from Metropolitan hospital in TPSR from 2006 to 2014 (listed in **Table 27**) and calculated the percentage ratio of control and experimental group in MTPSR. The percentage curve is shown in **figure 4**; even though both group showed a gradual decline in trend, in year 2010, the experimental group showed a more rapid decline comparing to the control group. The decrease of slope in experimental and control group was -0.22 % and -0.14% per year, respectively. Till the end of 2014, the total PSI in the control and experimental group is 2.77 and 1.3 times comparing to 2006. The percentage of PSI in the control group (1.2%) is the 2.4 fold more than that of experimental group. The data support the hypothesis that by using the SBAR protocol in a hospital's handoff system can be effective to avoid patient safety events. Pair-t test was used to analyze the difference between control and the experimental group (**Table 28**). The showed no significant difference in the pre-test of control vs experimental group. However after application of SBAR protocol in the experimental group, a significant improvement in patient safety was noted.

Table 27 PSI change before and after SBAR implement

Year	N	TPSR	Mean	Control	PSI %	Experimental	PSI %
2006	44	4,679	106	110	2.4%	100	2.1%
2007	47	5,245	112	108	2.1%	105	2.0%
2008	55	7,279	132	134	1.8%	128	1.8%
2009	56	10,638	190	188	1.8%	180	1.7%
2010	66	15,464	234	234	1.5%	225	1.5%
2011	66	19,334	293	288	1.5%	210	1.1%
2012	78	23,001	295	298	1.3%	190	0.8%
2013	77	24,800	322	310	1.3%	150	0.6%
2014	78	24,878	319	305	1.2%	130	0.5%

Ps1. "mean" calculated by **TPSR/N, e.g. 4,679/44 =106 in year 2006**

Ps2. PSI% calculated by **Ctrl/MTPSR** or **Exp/MTPSR, e.g. 110/4,679=2.4% in control group on year 2006**

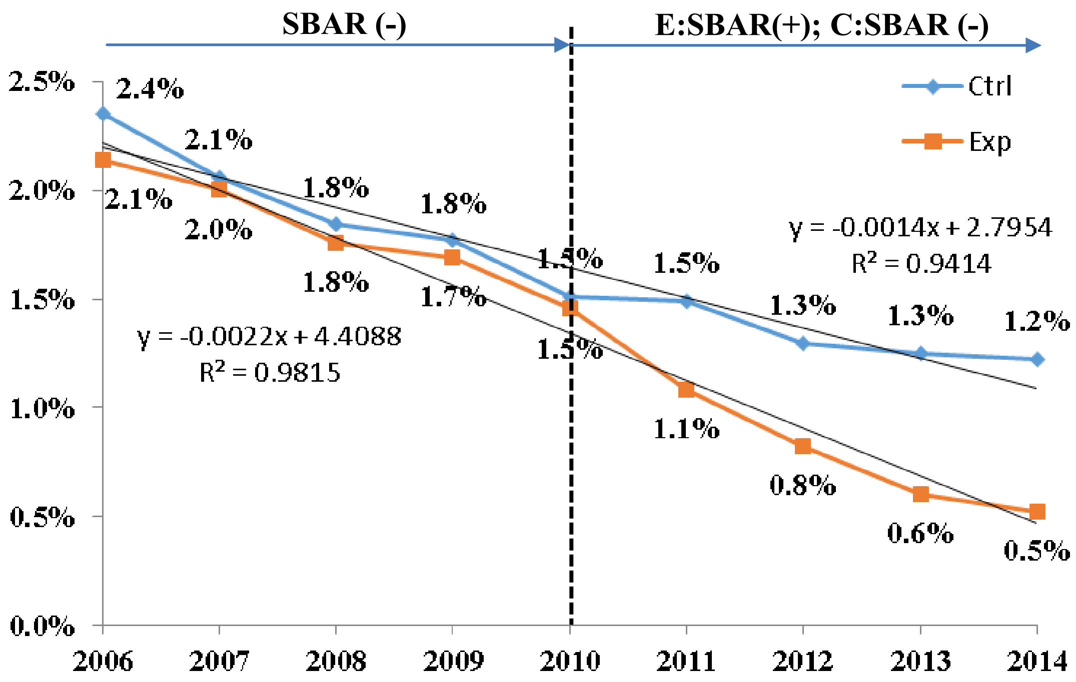

Figure 4. Percentage change of PSI in a hospital with/without SBAR implementation

Table 28 Pair t test on hospital with or without SBAR implementation

Intervention	Pre-test (2006-2009)		Post-test (2010-2014)		P
	mean	std	mean	std	
SBAR(+)	2.00%	0.21%	1.90%	0.21%	0.000
SBAR(-)	1.32%	0.38%	0.90%	0.38%	0.003
P	0.058		0.016		

6.4 To analyze PSI by communication errors

In this study, we performed an analysis regarding PSI events caused by communication errors in the hospital. **Table 29 to 31** is the analysis of control group, experimental group and reference group by communication errors. Communication errors includes the following four subtypes: (1) communications that were too late to be effective, (2) failure to communicate with all the relevant individuals on the team, (3) content that was not complete and accurate consistently, and (4) communications whose purposes were not achieved—i.e., issues were left unresolved until the point of urgency. The SBAR intervention aimed to improve patient safety and outcome via integrating collaboration between teams and units. This includes open communication, shared responsibilities for planning and problem solving, shared decision making, and coordination. In the following sections, we present the PSI data caused by communication errors.

6.4.1 Analysis of PSI induced by communication errors in control group

PSI induced by communication errors is presented in **Table 29**. The endo-tube incident (PSI 9) is the most common incident affected by communication errors. This was also found to be the most common indicated cause of critical incidents followed by insufficient communication between medical team staffs. The second most common affected indicator is PSI 8 (Injurious behavior). In general, injurious (including parasuicidal, suicidal and self-injuries) behavior occurs in three common situations: 1) behavioral complication of mental retardation, 2) as a symptom of Cluster B personality disorders, and 3) suicidality associated with depression (1) and (2). A proper communication skill by medical team is important in preventing this type of disorder behavior. Lastly, is drug related incidents, according to our study in Taiwan's hospital environment, drug-related incidents occurs most frequently during 8-10 am and 2-4 pm. The above mentioned time period is also the time for visiting staff to perform their clinical round. Therefore, reducing and avoiding this kind of incident via team work is needed to assure patient safety .

Table 29 to analyze PSI by communication errors in control group

Ctrl group	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	**110**	**108**	**134**	**188**	**234**	**288**	**298**	**310**	**305**
PSI1	3	1	2	4	5	4	5	5	5
	2.73%	0.93%	1.49%	2.13%	2.14%	1.39%	1.68%	1.61%	1.64%
PSI3	1	1	1	1	1	1	1	2	2
	0.91%	0.93%	0.75%	0.53%	0.43%	0.35%	0.34%	0.65%	0.66%
PSI4	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PSI5	1	2	2	2	4	5	3	4	2
	0.91%	1.85%	1.49%	1.06%	1.71%	1.74%	1.01%	1.29%	0.66%
PSI8	4	3	3	5	7	7	9	6	7
	3.64%	2.78%	2.24%	2.66%	2.99%	2.43%	3.02%	1.94%	2.30%
PSI9	5	4	6	8	8	8	10	14	14
	4.55%	3.70%	4.48%	4.26%	3.42%	2.78%	3.36%	4.52%	4.59%
PSI10	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PSI11	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PSI12	0	1	1	1	2	3	1	3	1
	0.00%	0.93%	0.75%	0.53%	0.85%	1.04%	0.34%	0.97%	0.33%
Number	**14**	**12**	**15**	**21**	**27**	**28**	**29**	**34**	**31**
%	**12.73%**	**11.11%**	**11.19%**	**11.17%**	**11.54%**	**9.72%**	**9.73%**	**10.97%**	**10.16%**

Ps. PSI% calculated by “individual PSI/total PSI”, e.g. PSI1: 3/110=2.73% in the control group on year 2006

6.4.2 Analysis of PSI induced by communication errors in experimental group

In the experimental group, we analyzed the effect of SBAR protocol in handoff system. The result is shown in **Table 30**. Both the injurious behaviors (PSI 8)endo-tube and endo-tube incidents (PSI 9) showed a significant drop in the ratio as well as the total number of incidents since 2010. All the other indicators of PSI induced by communication error also showed a declining trend after the implementation of SBAR protocol to the medical team, including physician, nurse, pharmacist, medical technologist, physical therapist, administration staff, patient and patient family etc… SBAR protocol is an important communication tool by systematic review and provided an additional measure in the caring status of patient within patient and medical staffs. From the table, one can see that at the end of the study (2014), the percentage of the adverse events was reduced by 5 to 10% when compared to the beginning of the study, we believe this is due to the SBAR protocol, improving communication quality.

Table 30 to analyze PSI by communication errors in experimental group

Exp group	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	**100**	**105**	**128**	**180**	**225**	**210**	**190**	**150**	**130**
PSI1	1	2	3	7	2	0	1	1	1
	1.00%	1.90%	2.34%	3.89%	0.89%	0.00%	0.53%	0.67%	0.77%
PSI3	0	0	0	1	1	1	1	0	0
	0.00%	0.00%	0.00%	0.56%	0.44%	0.48%	0.53%	0.00%	0.00%
PSI4	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PSI5	1	2	1	2	3	2	1	1	0
	1.00%	1.90%	0.78%	1.11%	1.33%	0.95%	0.53%	0.67%	0.00%
PSI8	2	2	3	4	2	2	2	2	2
	2.00%	1.90%	2.34%	2.22%	0.89%	0.95%	1.05%	1.33%	1.54%
PSI9	4	3	4	9	4	5	3	3	2
	4.00%	2.86%	3.13%	5.00%	1.78%	2.38%	1.58%	2.00%	1.54%
PSI10	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PSI11	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PSI12	1	1	1	1	1	2	2	0	0
	1.00%	0.95%	0.78%	0.56%	0.44%	0.95%	1.05%	0.00%	0.00%
Num	**9**	**10**	**12**	**24**	**13**	**12**	**10**	**7**	**5**
%	**9.00%**	**9.52%**	**9.38%**	**13.33%**	**5.78%**	**5.71%**	**5.26%**	**4.67%**	**3.85%**

Ps. PSI% calculated by “individual PSI/total PSI”, e.g. PSI1: 1/100=1% in the experimental group on year 2006

5.4.3 Analysis of PSI induced by communication errors in reference group

TPSR system is an annual report from Taiwan joint commission on hospital accreditation (TJCHA). In 2006 there were 171 hospitals and clinics reporting their patient safety events to TJCHA, till 2014 the reporting hospitals and clinics increased to 662 and the event number increased from 8,899 to 61,943 cases, as shown in **Table 31**. The PSI events presented here in **Table 31** were collected from hospitals with and without SBAR implementation as well as hospitals utilising different communication tools in their handoff system. Therefore, it is difficult identify a culprit for the change in PSI. Again, the top three PSIs induced by communication errors in the reference group is the endo-tube incidents (PSI 9), injurious behavior (PSI 8), and drug related incidents (PSI 1). Both the percentage and total incident number of endo-tube incidents are increasing. As mentioned earlier, endo-tube incidents was most commonly found to induce actual harm in patient safety, further leading to comorbidities when compared to other PSIs. It is therefore a critical issue to reduce this type of errors. Generally speaking, approximately 10% of the incidents were caused by communication errors in the TPSR system, and that is why we aim to investigate the effectiveness on PSI prevention by application of SBAR protocol in the handoff system. Unfortunately, it is important to keep in mind that even though SBAR protocol was implemented in Taiwan for five years (since year 2010), many hospitals and clinics did not participate in this program. So from the data shown in the TPSR annual report, we are not surprise to see no significant improvement in the reference group after year 2010.

Table 31 to analyze PSI by communication errors in reference group

TPSR group	2006	2007	2008	2009	2010	2011	2012	2013	2014
Hospital	**171**	**199**	**248**	**293**	**552**	**631**	**698**	**655**	**662**
Events	**8,899**	**14,941**	**25,280**	**32,918**	**50,205**	**54,740**	**59,798**	**63,882**	**61,943**
Mean(E/H)	**48**	**77**	**96**	**119**	**85**	**87**	**88**	**90**	**91**
PSI1	232	287	362	535	759	1125	1593	1789	919
	2.61%	1.92%	1.43%	1.63%	1.51%	2.06%	2.66%	2.80%	1.48%
PSI3	45	86	147	105	158	300	412	487	373
	0.51%	0.58%	0.58%	0.32%	0.31%	0.55%	0.69%	0.76%	0.60%
PSI4	10	12	33	29	76	97	59	112	101
	0.11%	0.08%	0.13%	0.09%	0.15%	0.18%	0.10%	0.18%	0.16%
PSI5	60	254	408	489	324	509	412	850	1039
	0.67%	1.70%	1.61%	1.49%	0.65%	0.93%	0.69%	1.33%	1.68%
PSI8	317	373	621	803	1110	1239	1534	1700	1502
	3.56%	2.50%	2.46%	2.44%	2.21%	2.26%	2.57%	2.66%	2.42%
PSI9	352	612	820	1247	1529	2280	2645	2935	2697
	3.96%	4.10%	3.24%	3.79%	3.05%	4.17%	4.42%	4.59%	4.35%
PSI10	5	8	29	24	38	42	19	66	30
	0.06%	0.05%	0.11%	0.07%	0.08%	0.08%	0.03%	0.10%	0.05%
PSI11	2	2	10	12	9	26	28	45	6
	0.02%	0.01%	0.04%	0.04%	0.02%	0.05%	0.05%	0.07%	0.01%
PSI12	87	89	249	307	249	302	300	342	569
	0.98%	0.60%	0.98%	0.93%	0.50%	0.55%	0.50%	0.54%	0.92%
Number	**1110**	**1723**	**2679**	**3551**	**4252**	**5920**	**7002**	**8326**	**7236**
%	**12.47%**	**11.53%**	**10.60%**	**10.79%**	**8.47%**	**10.81%**	**11.71%**	**13.03%**	**11.68%**

Ps. PSI% calculated by “individual PSI/total PSI”, e.g. PSI1: 232/8,899=2.61% in the reference group on year 2006

5.5 Comparing the change of PSI induced by communication errors within control, experimental and reference group

Figure 5 is the comparison of percentage of change in PSI induced by communication error between the control group, experimental group and reference group. From this figure, we can see that the year 2010 is a diverging point, where the experimental group was found to show the maximum percentage change. We believe this is due to the implementation of SBAR protocol in the handoff system in the experimental group, even though PSI is a lag indicator in this setting since they were collected and calculated in the following year after the introduction of SBAR protocol. However, no significant difference was noted between the control and reference group (blue line and green line). The control group made no change in their handoff system, so the reflected data is not surprising. The data in the reference group (TPSR) is collected from a mixture of hospitals with and without the implementation of SBAR protocol as well as implementation of other communication tools. No significant change was noted in the reference group. With continuous SBAR implementation, the number of PSIs induced by communication errors showed a gradual reduction, and by the end of year 2014, only 3.85% of the PSIs is induced by communication errors. Patient safety is in a key indicator to hospital accreditation nowadays. This result suggests that utilizing a well established and standardized communication tool in the medical team or in patient groups plays an important role in ensuring patient safety during treatment or operation process.

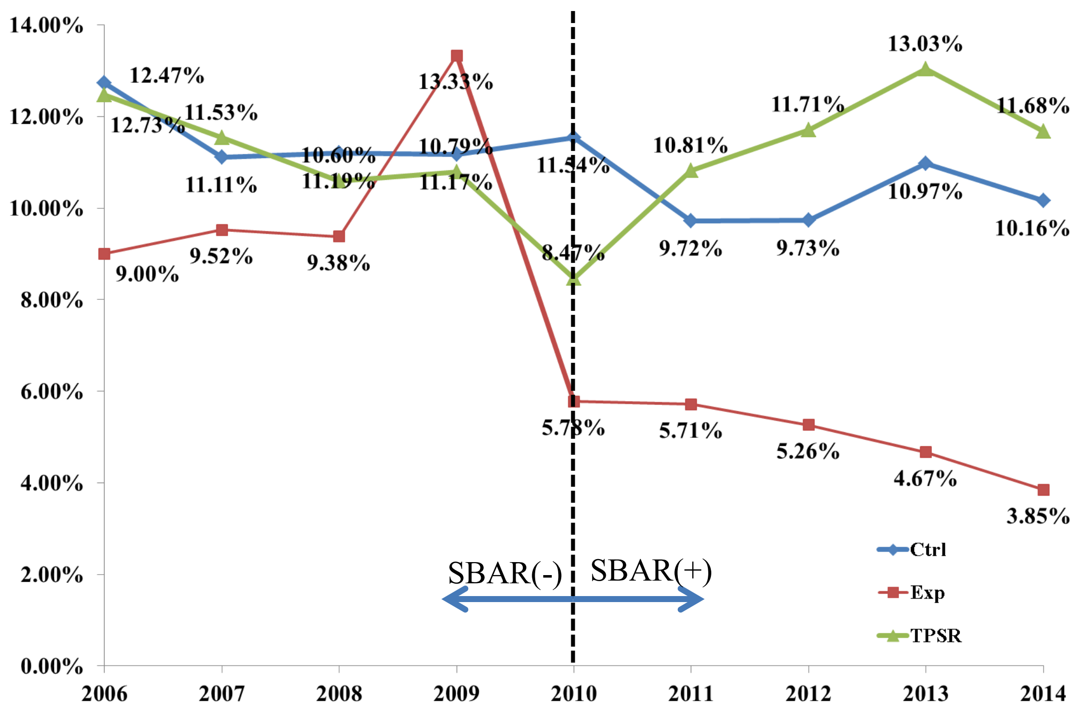

Figure 5 The percentage change of PSI induced by communication errors

5.6 To study the effect of patient safety events on patient health

In this study we also analyzed the severity of harm in patient care quality caused by patient safety events. Level of harm was classified into four categories being injury, non-injury, near miss and no account. Injury level also further be breakdown into five subtype being death, extreme, severe, moderate and mild. The injury levels are defined as below.

- Death: Resulting in the death of patient.
- Extremely severe: Causing permanent disability or dysfunction of a patient, such as physical disability and brain damage.
- Severe: Events resulting in patient injuries, which require additional visit, evaluation, and observation as well as operation, hospitalization, or extending stays in the hospital (e.g bone fracture or pneumothorax).
- Moderate: Events resulting in patient injuries, which require additional visit, evaluation, observation, or processing (e.g measuring blood pressure, pulse, and blood sugar more than ordinal, X-ray, blood tests, urine analysis, wound dressing, stitching, hemostatic therapy, 1~2 dose of medication.)
- Mild: Events causing injuries, but do not need or require slight treatment, without additional care, such as red skin, scratch, and bruise.

This classification was defined according to the level of harm and patient outcome standard from TPSR report system. An **'incident'** is any event or circumstance that led to unintended or unexpected harm, loss or damage. A **'Near Miss'** is an event or occurrence which, due to skillful management or a fortunate turn of events that would have led to harm, loss or damage. A follow up analysis was performed in an incidental event as suggested by TJCHA, thus root cause analysis (RCA) system was adapted by the hospital administration team. RCA provided a platform in reviewing the incident and through this analysis, tone will be able to distinguish whether the harm is preventable or not

5.6.1 To study the effect of patient safety events on patient health in control group

The effect of patient safety events on patient health in control group is presented in **Table**

32. From the result, one can see that the percentage of actual injury induced by PSE was approximately 40% per year with the most common level of injury falling between moderate and mild injury. No significant change was noted in harmful patient caring quality from 2006 to 2014. Within all level of harm, approximately 1% results in death of the patient. Severe level of harm was approximately 3% per year, and improvement can be made to secure patient safety. In the event of death or serious injury, reporting must be made immediately. A skillful way to communicate and break the news to patient or their family is important in avoiding conflicts.

Table 32 Influence on patient health by patient safety event in control group

Ctrl. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	1	1	1	2	1	3	2	3	3
		0.91%	0.93%	0.75%	1.06%	0.43%	1.04%	0.67%	0.97%	0.98%
	Extreme	0	0	0	0	0	1	0	1	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.35%	0.00%	0.32%	0.00%
	Severe	3	3	5	4	5	9	9	11	9
		2.73%	2.78%	3.73%	2.13%	2.14%	3.13%	3.02%	3.55%	2.95%
	Moderate	22	19	22	39	48	39	42	57	52
		20.00%	17.59%	16.42%	20.74%	20.51%	13.54%	14.09%	18.39%	17.05%
	Mild	17	15	25	34	42	43	60	40	50
		15.45%	13.89%	18.66%	18.09%	17.95%	14.93%	20.13%	12.90%	16.39%
	subtotal	40	47	48	54	86	115	107	123	117
	%	36.36%	43.52%	35.82%	28.72%	36.75%	39.93%	35.91%	39.68%	38.36%
No injury		24	19	29	47	43	70	70	65	61
		21.82%	17.59%	21.64%	25.00%	18.38%	24.31%	23.49%	20.97%	20.00%
Near miss		3	4	4	8	9	8	8	10	13
		2.73%	3.70%	2.99%	4.26%	3.85%	2.78%	2.68%	3.23%	4.26%
NA		40	47	48	54	86	115	107	123	117
		36.36%	43.52%	35.82%	28.72%	36.75%	39.93%	35.91%	39.68%	38.36%
Total		**110**	**108**	**134**	**188**	**234**	**288**	**298**	**310**	**305**
%		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Ps. “%” calculated by “individual level/total PSI”, e.g. %: 1/110=0.91% in death level on year 2006

5.6.2 To study the effect of patient safety events on patient health in experimental group

The effect of patient safety events on patient health in experimental group is shown in **Table 33**. Comparing to the control group, the percentage of moderate and mild injury level is approximately 40% of the total events. No injury level falls between 30 to 40%. Near miss level varies from 17 to 27%. Although a "near miss" didn't cause actual harm to the patient, the potential to induce injury exists, thus they need to be managed carefully. The total events in the experimental group showed an increasing trend from 100 cases in 2006 to 130 cases in 2014 (1.3 times increase from 2006). From 2010 onward, where the SBAR protocol was introduced into the handoff system of the experimental group, the numbers of critical injures such as severe, extreme, and death was fewer than that of the control hospital. Indeed, these fatal incidents need to be avoided by taking actions such as communication tool, education system, management policy and audit system.

Table 33 The influence on patient health by patient safety event in experimental group

Exp. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	1	1	1	1	2	0	0	0	0
		1.00%	0.95%	0.78%	0.56%	0.89%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	3	3	3	3	2	1	2	1	1
		3.00%	2.86%	2.34%	1.67%	0.89%	0.48%	1.05%	0.67%	0.77%
	Moderate	21	31	37	36	48	33	27	30	26
		21.00%	29.52%	28.91%	20.00%	21.33%	15.71%	14.21%	20.00%	20.00%
	Mild	15	20	20	27	34	34	34	30	26
		15.00%	19.05%	15.63%	15.00%	15.11%	16.19%	17.89%	20.00%	20.00%
	Subtotal	40	55	61	67	86	68	63	61	53
	%	40.00%	52.38%	47.66%	37.23%	38.22%	32.38%	33.15%	40.67%	40.77%
No injury		35	28	38	73	83	79	87	56	51
		35.00%	26.67%	29.69%	40.56%	36.89%	37.62%	45.79%	37.33%	39.23%
Near miss		21	18	26	35	49	55	36	29	23
		21.00%	17.14%	20.31%	19.44%	21.78%	26.19%	18.95%	19.33%	17.69%
NA		4	4	3	5	7	8	4	4	3
		4.00%	3.81%	2.34%	2.78%	3.11%	3.81%	2.11%	2.67%	2.31%
Total		**100**	**105**	**128**	**180**	**225**	**210**	**190**	**150**	**130**
%		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Ps. "%" calculated by "individual level/total PSI", e.g. %: 1/100=1% in death level on year 2006

5.6.3 To study the effect of patient safety events on patient health in reference group

Table 34 is the effect of patient safety events on patient health in the control group extracted from TPSR annual report in Taiwan. The increase in reported incidence was caused by the disclosure policy in hospitals providing a more transparent and safety environment.The total events increased from 8176 events in 2006 to 60559events in 2014, 7.4 times more than that of 2006. Till the end of year 2014, there were 12243, 7387, 832, 61 and 371 cases causing an injury level of mild, moderate, severe, extreme and death, respectively. The injury rate decreased from 49.21% in 2006 to 34.5% in 2014. The percentage of "near miss" increased throughout the study period (2006-2014). Even though the errors or incident occurred did not induce actual harm to the patients, this has reflected numerous problems in the medical system such as unfavorable working conditions (long working hours and short of human resource) for medical staffs. To effectively avoid repetition of these errors that can potentially injures patient, improvements must be made on identifying and devising a plan for the underlying causes associated with near misses. Systemic problems can be identified via the reports filed to TPSR. Errors that occur but do not result in patient harm, and errors that could have caused harm but were mitigated in some manner before they ever reached the patient were termed near misses. Reported number of near misses are as frequent as adverse events, they can provide invaluable information for proactively reducing errors. Analysis of reported errors have revealed many "hidden risks" (near misses, dangerous situations, and deviations or variations) which pointed out various insufficiency of the system as well as unintentional acts of clinician performance that may eventually cause patients harm.

Table 34 The influence on patient health by patient safety event in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	88	110	224	233	303	338	365	329	371
		1.08%	0.72%	0.94%	0.67%	0.65%	0.61%	0.60%	0.56%	0.61%
	Extreme	21	36	52	92	92	113	126	87	61
		0.26%	0.23%	0.22%	0.26%	0.20%	0.20%	0.21%	0.15%	0.10%
	Severe	302	503	622	768	873	986	961	861	832
		3.69%	3.27%	2.61%	2.20%	1.87%	1.79%	1.57%	1.46%	1.37%
	Moderate	2478	3518	4163	4637	5291	6745	7049	7330	7387
		30.31%	22.88%	17.50%	13.25%	11.33%	12.22%	11.52%	12.40%	12.20%
	Mild	1134	2329	3261	6531	8971	10503	11287	12066	12243
		13.87%	15.15%	13.71%	18.67%	19.21%	19.03%	18.45%	20.42%	20.22%
	Subtotal	4,023	6,496	8,322	12,261	15,530	18,685	19,788	20,673	20,894
	%	49.21%	42.25%	34.98%	35.05%	33.26%	33.85%	32.35%	34.99%	34.50%
No injury		3539	5482	8472	12700	16983	20354	22716	20618	22068
		43.29%	35.66%	35.61%	36.30%	36.37%	36.89%	37.13%	34.89%	36.44%
Near miss		311	2692	6022	8004	12086	13667	16039	15938	16273
		3.80%	17.51%	25.32%	22.88%	25.88%	24.77%	26.22%	26.97%	26.87%
NA		303	705	972	2022	2102	2476	2631	1867	1324
		3.71%	4.59%	4.09%	5.78%	4.50%	4.49%	4.30%	3.16%	2.19%
Total		**8176**	**15375**	**23788**	**34987**	**46701**	**55182**	**61174**	**59096**	**60559**
%		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Ps. “%” calculated by “individual level/total PSI”, e.g. %: 88/8,176=1.08% in death level on year 2006

5.7 To analyze the degree of injury by each PSI

In this section we investigate the degree of injury in each of the patient safety indicator. Each of the different patient safety indicators showed a different level of injury in patient caring quality, we further discuss them in the following sections.

5.7.1 The effect of drug-related incidents (PSI1) on patient health

Level of injury induced by drug-related incidents was described in **figure 6** and **Table 35-37**. **Fig. 6** is the graph showing drug-related incident change throughout the study. The experimental group showed a declining trend from 30.19% in 2006, lowest reaching 4.9% in 2011 followed by a slight increase to 12% in 2014. The trend showed a significant improvement in the incident caused by the department of pharmacy. The introduction of SBAR protocol in the handoff system was an important intervention in this department. The rate of injury was lower than that of the control group after SBAR implementation. The control group also showed a declining trend from 38.6% in 2006 to 20.43% in 2014, however, this change is not as significant in the experimental group. Both the control and experimental groups showed a declining trend since 2006, reflecting the importance of patient safety in the department of pharmacy. In contrast, the change in the reference group (TPSR system) did not show much change, suggesting that many hospitals within the nation have not yet taken an efficient action to avoid the incidents caused by the department of pharmacy. **Table 35** is the result collected and analyzed from the control group. The number of injury events increased over time, even though the percentage of the incident decrease. **Table 36** is the result of experimental group with SBAR protocol introduced in the handoff system of the medical team; Both the total number of events and the percentage of incident in this group showed a significant reduction when compared to the baseline. The result of reference control group (TPSR system) is shown in **Table 37**. Both the total number of events and the percentage of the incident did not show a significant reduction when compared to the baseline, suggesting no effective intervention was performed or taken by the pharmacy department in most of the hospital.

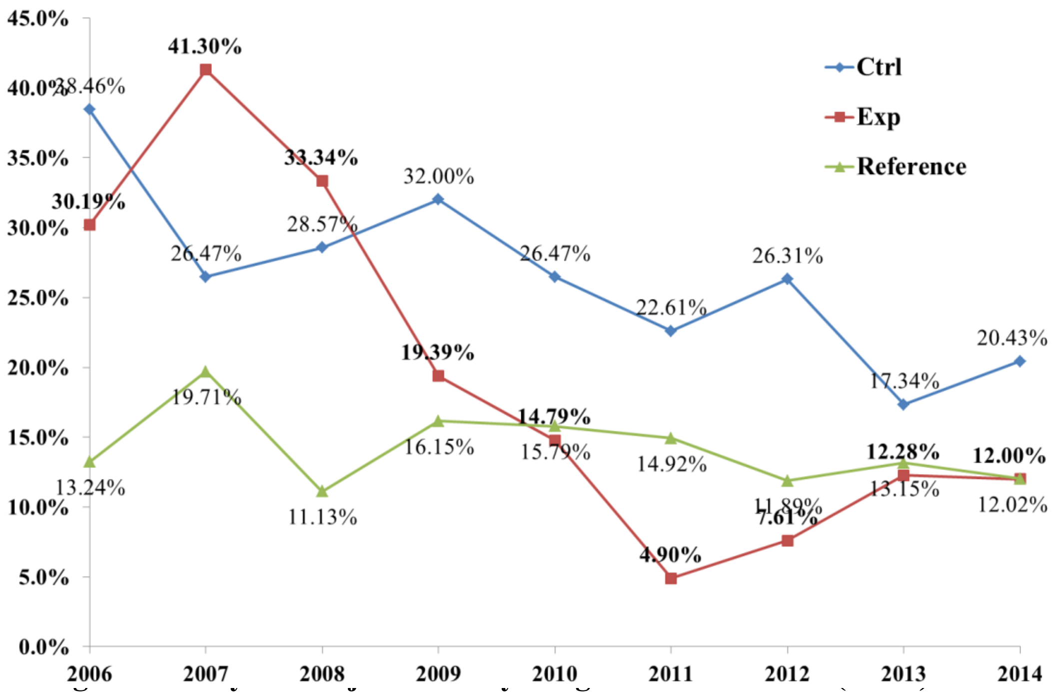

Table 35 Injury level by drug-related incidents (PSI 1) in control group

Ctrl. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	0	0	1	0	1	1	1	1	1
		0.00%	0.00%	2.38%	0.00%	1.47%	1.19%	1.05%	1.02%	1.08%
	Moderate	3	3	4	5	5	8	7	8	8
		11.54%	8.82%	9.52%	10.00%	7.35%	9.52%	7.37%	8.16%	8.60%
	Mild	7	6	7	11	12	10	17	8	10
		26.92%	17.65%	16.67%	22.00%	17.65%	11.90%	17.89%	8.16%	10.75%
	subtotal	10	9	12	16	18	19	25	17	19
	%	38.46%	26.47%	28.57%	32.00%	26.47%	22.61%	26.31%	17.34%	20.43%
No injury		10	15	8	3	18	35	26	30	32
		38.46%	44.12%	19.05%	6.00%	26.47%	41.67%	27.37%	30.61%	34.41%
Near miss		5	10	20	26	28	30	42	48	38
		19.23%	29.41%	47.62%	52.00%	41.18%	35.71%	44.21%	48.98%	40.86%
NA		1	0	2	5	4	0	2	3	4
		3.85%	0.00%	4.76%	10.00%	5.88%	0.00%	2.11%	3.06%	4.30%
Total		**26**	**34**	**42**	**50**	**68**	**84**	**95**	**98**	**93**

Ps. "%" calculated by "individual level/total PSI1", e.g. %: 0/26=0.00% in death level on year 2006

Table 36 Injury level by drug-related incidents (PSI 1) in experimental group

Exp. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	1	1	1	0	0	0	0
		0.00%	0.00%	1.52%	1.02%	0.87%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	1	1	1	0	0	0	1	0	0
		1.89%	2.17%	1.52%	0.00%	0.00%	0.00%	1.09%	0.00%	0.00%
	Moderate	6	6	6	5	5	3	3	3	3
		11.32%	13.04%	9.09%	5.10%	4.35%	2.94%	3.26%	5.26%	6.00%
	Mild	9	12	14	13	11	2	3	4	3
		16.98%	26.09%	21.21%	13.27%	9.57%	1.96%	3.26%	7.02%	6.00%
	subtotal	16	19	22	19	17	5	7	7	6
	%	30.19%	41.30%	33.34%	19.39%	14.79%	4.90%	7.61%	12.28%	12.00%
No injury		22	16	24	53	60	57	60	30	29
		41.51%	34.78%	36.36%	54.08%	52.17%	55.88%	65.22%	52.63%	58.00%
Near miss		12	10	20	25	35	40	25	20	15
		22.64%	21.74%	30.30%	25.51%	30.43%	39.22%	27.17%	35.09%	30.00%
NA		3	1	0	1	3	0	0	0	0
		5.66%	2.17%	0.00%	1.02%	2.61%	0.00%	0.00%	0.00%	0.00%
Total		**53**	**46**	**66**	**98**	**115**	**102**	**92**	**57**	**50**

Ps. "%" calculated by "individual level/total PSI1", e.g. %: 0/53=0.0 % in death level on year 2006

Table 37 Injury level by drug-related incidents (PSI 1) in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	0	0	1	1	2	2	3
		0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.02%	0.02%	0.02%
	Extreme	1	1	3	6	17	6	7	13	0
		0.11%	0.07%	0.08%	0.13%	0.21%	0.07%	0.06%	0.10%	0.00%
	Severe	3	9	12	27	42	29	20	42	13
		0.32%	0.67%	0.33%	0.56%	0.51%	0.32%	0.16%	0.34%	0.10%
	Moderate	53	102	124	247	383	400	427	454	533
		5.66%	7.62%	3.41%	5.15%	4.69%	4.35%	3.38%	3.63%	4.04%
	Mild	67	152	266	494	846	936	1045	1132	1037
		7.15%	11.35%	7.31%	10.31%	10.37%	10.17%	8.27%	9.06%	7.86%
	subtotal	124	264	405	774	1289	1372	1501	1643	1586
	%	13.24%	19.71%	11.13%	16.15%	15.79%	14.92%	11.89%	13.15%	12.02%
No injury		700	818	2108	2485	4081	3835	5398	4786	5123
		74.71%	61.09%	57.90%	51.85%	50.02%	41.68%	42.71%	38.31%	38.82%
Near miss		84	197	1006	1234	2446	3548	4680	5608	6048

	8.96%	14.71%	27.63%	25.75%	29.98%	38.56%	37.03%	44.89%	45.83%
NA	29	60	122	300	342	446	1060	456	439
	3.09%	4.48%	3.35%	6.26%	4.19%	4.85%	8.39%	3.65%	3.33%
Total	**937**	**1339**	**3641**	**4793**	**8158**	**9201**	**12639**	**12493**	**13196**

Ps. "%" calculated by "individual level/total PSI1", e.g. %: 0/937=0.0 % in death level on year 2006

5.7.2 The effect of falling incidents (PSI 2) on patient health

The result of falling incidents (PSI 2) is shown in **Figure 7** and **Table 38-40**. **Fig.7** is the graph showing change in falling incidents throughout the study period. The experimental group (**Table 39**) shows a clear decline of incident from 94.7% in 2010 to 21.4% in 2014; a significant reduction in this incident was shown by the intervention of SBAR in the handoff system. Till the end of 2014, percentage of no injury incidence is 71.43%, however, no significant change is noted via statistic analysis. The control group (**Table 38**) had a fluctuating trend ranging from 15.9% to 39.4%, however this change was not as significant as that of the experimental group. Albeit when compared to the control group, the control group has a lower incident in inducing actual injury to the patient, the total event of injury in the experimental group is lower than the control group. In contrast, in the reference group (TPSR system) the incident rate of actual harm did not show much change, with the percentage ranging from 47.4% to 54.9% throughout the study period (**Table 40)**. The number of events resulting in death and extreme injury is few, but a large portion of the incident ends up in moderate and mild injury. Even though more than 50% of the events end up in the no injury category, at the end of the study, the total number of injury events caused by falling incidents from TPSR report showed a growth of 8.82 times from the baseline..

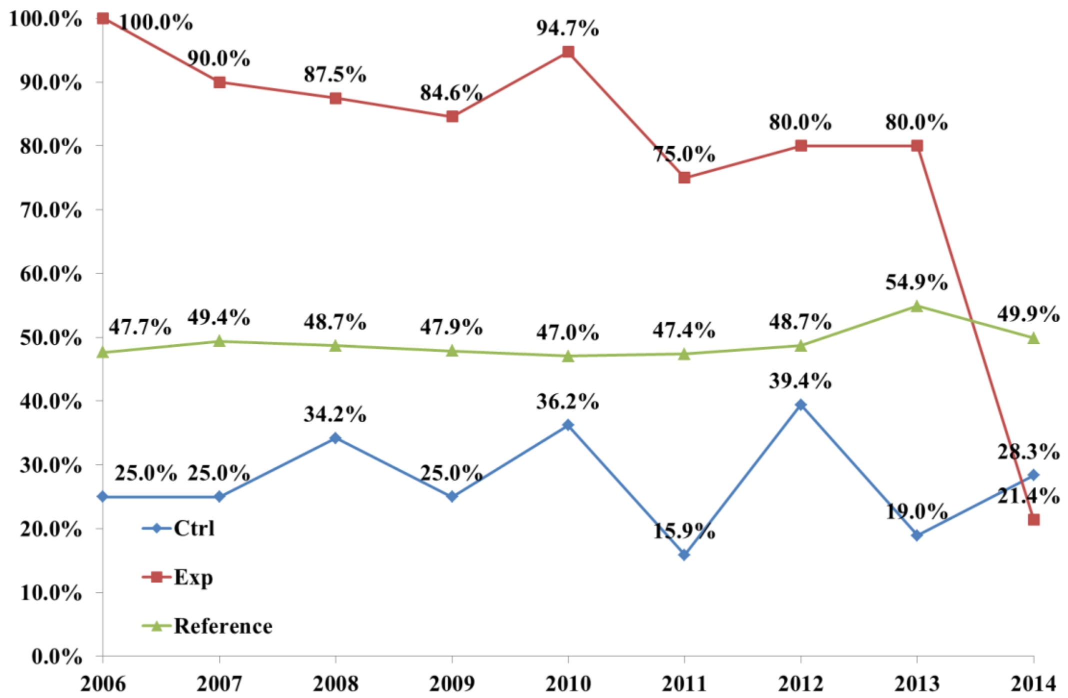

Figure 7 Analysis of injure level by falling incidents (PSI 2)

Table 38 Injury level by falling incidents (PSI 2) in control group

Ctrl. group		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	1	1	1	1	2	1	1	2	1
		5.00%	5.00%	2.63%	2.08%	3.45%	2.27%	1.41%	3.45%	1.67%
	Moderate	3	3	2	5	9	6	11	3	6
		15.00%	15.00%	5.26%	10.42%	15.52%	13.64%	15.49%	5.17%	10.00%
	Mild	1	1	10	6	10	0	16	6	10
		5.00%	5.00%	26.32%	12.50%	17.24%	0.00%	22.54%	10.34%	16.67%
	Subtotal	5	5	13	12	21	7	28	11	17
	%	25.00%	25.00%	34.21%	25.00%	36.21%	15.91%	39.44%	18.96%	28.34%
No injury		15	14	24	35	36	36	42	46	41
		75.00%	70.00%	63.16%	72.92%	62.07%	81.82%	59.15%	79.31%	68.33%
Near miss		0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA		0	1	1	1	1	1	1	1	2
		0.00%	5.00%	2.63%	2.08%	1.72%	2.27%	1.41%	1.72%	3.33%
Total		**20**	**20**	**38**	**48**	**58**	**44**	**71**	**58**	**60**

Ps. "%" calculated by "individual level/total PSI2", e.g. %: 0/20=0.0 % in death level on year 2006

Table 39 Injury level by falling incidents (PSI 2) in experimental group

Exp. group		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Injury	Death	0	1	0	0	1	0	0	0	0
		0.00%	10.00%	0.00%	0.00%	5.26%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	1	1	1	2	2	0	0	1	1
		14.29%	10.00%	12.50%	15.38%	0.53%	0.00%	0.00%	20.00%	7.14%
	Moderate	6	7	6	8	8	2	3	3	2
		85.71%	70.00%	75.00%	61.54%	42.11%	50.00%	60.00%	60.00%	14.29%
	Mild	0	0	0	1	7	1	1	0	0
		0.00%	0.00%	0.00%	7.69%	36.84%	25.00%	20.00%	0.00%	0.00%
	Subtotal	7	9	7	11	18	3	4	4	3
	%	100.0%	90.0%	87.5%	84.6%	94.7%	75.0%	80.0%	80.0%	21.4%
No injury		0	0	0	1	0	0	0	0	10
		0.00%	0.00%	0.00%	7.69%	0.00%	0.00%	0.00%	0.00%	71.43%
Near miss		0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA		0	1	1	1	1	1	1	1	1
		0.00%	10.00%	12.50%	7.69%	5.26%	25.00%	20.00%	20.00%	7.14%
Total		**7**	**10**	**8**	**13**	**19**	**4**	**5**	**5**	**14**

Ps. "%" calculated by "individual level/total PSI2", e.g. %: 0/7=0.0 % in death level on year 2006

Table 40 Injury level by falling incidents (PSI 2) in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	1	2	3	3	3	8	4	4	10
		0.07%	0.09%	0.10%	0.06%	0.04%	0.09%	0.04%	0.04%	0.08%
	Extreme	2	3	5	9	13	14	16	17	12
		0.14%	0.13%	0.17%	0.18%	0.19%	0.16%	0.17%	0.15%	0.10%
	Severe	74	90	132	149	388	392	303	280	299
		5.29%	3.96%	4.51%	2.91%	5.76%	4.54%	3.22%	2.52%	2.42%
	Moderate	176	376	277	351	509	645	847	2047	2125
		12.59%	16.53%	9.46%	6.86%	7.56%	7.47%	9.00%	18.45%	17.23%
	Mild	110	388	588	1846	2546	2878	3182	3457	3655
		7.87%	17.06%	20.08%	36.06%	37.81%	33.33%	33.81%	31.16%	29.64%
	Subtotal	363	859	1005	2358	3459	3937	4352	5805	6101
	%	25.97%	37.77%	34.31%	46.06%	51.37%	45.59%	46.24%	52.33%	49.48%
No injury		1004	1311	1756	2483	2938	4240	4877	5156	6147
		71.82%	57.65%	59.95%	48.51%	43.63%	49.10%	51.82%	46.48%	49.85%
Near miss		7	11	27	39	62	79	11	28	8
		0.50%	0.48%	0.92%	0.76%	0.92%	0.91%	0.12%	0.25%	0.06%
NA		24	93	141	239	275	379	172	104	74
		1.72%	4.09%	4.81%	4.67%	4.08%	4.39%	1.83%	0.94%	0.60%
Total		1398	2274	2929	5119	6734	8635	9412	11093	12330

Ps. "%" calculated by "individual level/total PSI2", e.g. %: 1/1,398=0.07 % in death level on year 2006

5.7.3 The effect of medical procedure incidents (PSI 5) on patient health

The result of medical procedure incidents is shown in **Table 41-43**. The control group did not have any injury event before 2010, and after that the number of injuries was few (**Table 41**). Regarding the experimental group (**Table 42**), the number of injury event is similar to that of thecontrol group, no significant change is noted after SBAR intervention. In contrast, the reference group (TPSR system) also remains relatively steady, with the incident percentage ranging from 54.91% to 61.29% (**Table 43**). Total event number increased from 364 in 2006 to 1136 in 2016 =. The percentage of no injury was approximately 30% throughout and the percentage of near miss ranged from 4% to 7 %. The totally number of events in medical procedure incidents from TPSR report showed a 2.92 times increase in 2014 when compared to the baseline.

Table 41 Injury level by medical incidents (PSI 5) in control group

Ctrl. group			2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death		0	0	0	0	0	0	0	0	0
			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme		0	0	0	0	0	0	0	0	0
			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe		0	0	0	0	0	0	0	0	1
			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	20.00%
	Moderate		0	0	0	0	0	1	1	1	1
			0.00%	0.00%	0.00%	0.00%	0.00%	20.00%	50.00%	25.00%	20.00%
	Mild		0	0	0	0	0	2	1	1	1
			0.00%	0.00%	0.00%	0.00%	0.00%	40.00%	50.00%	25.00%	20.00%
		Subtotal	0	0	0	0	0	3	2	2	3
		%	0.00%	0.00%	0.00%	0.00%	0.00%	60.00%	100.0%	50.00%	60.00%
No injury			0	0	0	0	0	2	0	1	1
			0.00%	0.00%	0.00%	0.00%	0.00%	40.00%	0.00%	25.00%	20.00%
Near miss			0	0	0	0	0	0	0	1	1
			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	25.00%	20.00%
NA			0	0	0	0	0	0	0	0	0
			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Total	0	0	0	0	0	5	2	4	5

Ps. "%" calculated by "individual level/total PSI5", e.g. %: 0/5=0.0 % in death level on year 2014

Table 42 Injury level by medical incidents (PSI 5) in experimental group

Exp. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
	Death	1	0	0	0	0	0	0	0	0
		50.0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Injury	Severe	1	1	1	0	0	1	1	0	0
		50.0%	50.0%	50.0%	0.00%	0.00%	20.00%	20.00%	0.00%	0.00%
	Moderate	0	1	1	1	1	0	0	0	0
		0.00%	50.0%	50.0%	50.0%	50.0%	0.00%	0.00%	0.00%	0.00%
	Mild	0	0	0	1	1	1	1	1	1
		0.00%	0.00%	0.00%	50.0%	50.0%	20.00%	20.00%	50.00%	50.00%
	Subtotal	2	2	2	2	2	2	2	1	1
	%	100.0%	100.0%	100.0%	100.0%	100.0%	40.00%	40.00%	50.00%	50.00%
No injury		0	0	0	0	0	3	2	1	1
		0.00%	0.00%	0.00%	0.00%	0.00%	60.00%	40.00%	50.00%	50.00%
Near miss		0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA		0	0	0	0	0	0	1	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	20.00%	0.00%	0.00%
Total		**2**	**2**	**2**	**2**	**2**	**5**	**5**	**2**	**2**

Ps. "%" calculated by "individual level/total PSI5", e.g. %: 1/2=50.0 % in death level on year 2006

Table 43 Injury level by medical incidents (PSI 5) in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	6	14	18	10	17	11	20	20	14
		0.71%	0.90%	0.86%	0.89%	1.09%	0.71%	1.01%	0.98%	0.73%
	Extreme	5	10	12	5	5	10	7	11	11
		0.59%	0.64%	0.57%	0.45%	0.32%	0.65%	0.36%	0.54%	0.57%
	Severe	71	140	155	134	153	145	160	102	168
		8.40%	9.01%	7.39%	11.95%	9.81%	9.42%	8.12%	6.23%	8.74%
	Moderate	207	396	465	280	384	390	459	476	472
		24.50%	25.48%	22.16%	24.98%	24.63%	25.32%	23.29%	23.36%	24.56%
	Mild	75	254	312	258	377	310	486	517	471
		20.71%	22.72%	26.64%	23.02%	24.18%	20.13%	24.66%	25.37%	24.51%
	Subtotal	364	814	962	687	936	866	1132	1126	1136
	%	54.91%	58.75%	57.62%	61.29%	60.03%	56.23%	57.44%	56.48%	59.11%
No injury		262	420	615	300	389	432	588	571	596
		31.01%	27.03%	29.31%	26.76%	24.95%	28.05%	29.83%	28.02%	31.01%
Near miss		24	87	156	87	108	106	81	138	104
		5.21%	5.60%	7.44%	7.76%	6.93%	6.88%	4.11%	6.77%	5.41%
NA		32	137	118	47	126	136	170	108	86
		8.88%	8.82%	5.62%	4.19%	8.08%	8.83%	8.63%	8.73%	4.47%
Total		**682**	**1458**	**1851**	**1121**	**1559**	**1540**	**1971**	**1943**	**1922**

Ps. "%" calculated by "individual level/total PSI5", e.g. %: 6/682=0.71 % in death level on year 2006

5.7.4 The effect of law accidents (PSI 7) on patient health

The result of law incident is shown in **Table 44-46.** Both the control group (**Table 44**) and the experimental group (**Table 45**) showed no significant change through the study period (even though an slight increase in the number of events was noted in the control group, especially in 2014). In contrast, in the reference group (TPSR system) the incidence of law accident increased throughout the study period, ranging from 26.84% to 79.57% (**Table 46**). Total event number increased from 117 in 2006 to 1628 in 2014. By the end of the study, the rate of no injury declined to 0.54%, suggesting insufficient action taken to reduce actual harm The total number of injury by law accidents from TPSR report at the end of the study showed a 5.64 times increase from baseline.

Table 44 Injury level by law accidents (PSI 7) in control group

Ctrl. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
	Extreme	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
	Severe	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
	Moderate	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
	Mild	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	4 50.00%	1 33.33%	2 50.00%	6 50.00%
	Subtotal %	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	4 50.00%	1 33.33%	2 50.00%	6 50.00%
No injury		0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 12.50%	1 33.33%	1 25.00%	3 25.00%
Near miss		0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 12.50%	0 0.00%	0 0.00%	2 16.67%
NA		0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	2 25.00%	1 33.33%	1 25.00%	1 8.33%
Total		**0**	**0**	**0**	**0**	**0**	**8**	**3**	**4**	**12**

Ps. “%” calculated by “individual level/total PSI7”, e.g. %: 4/8=50.0 % in mild level on year 2011

Table 45 Injury level by law accidents (PSI 7) in experimental group

Exp. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Moderate	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Mild	0	0	0	0	0	1	1	0	1
		0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	12.50%	0.00%	33.33%
	Subtotal	0	0	0	0	0	1	1	0	1
	%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	12.50%	0.00%	33.33%
No injury		0	0	0	0	0	1	3	2	0
		0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	37.50%	50.00%	0.00%
Near miss		0	0	0	0	0	4	3	1	1
		0.00%	0.00%	0.00%	0.00%	0.00%	40.00%	37.50%	25.00%	33.33%
NA		0	0	0	0	0	4	1	1	1
		0.00%	0.00%	0.00%	0.00%	0.00%	40.00%	12.50%	25.00%	33.33%
Total		**0**	**0**	**0**	**0**	**0**	**10**	**8**	**4**	**3**

Ps. "%" calculated by "individual level/total PSI7", e.g. %: 1/10=10.0 % in mild level on year 2011

Table 46 Injury level by law accidents (PSI 7) in control group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	2	0	3	2	9	3	9	3	0
		0.46%	0.00%	0.30%	0.14%	0.48%	0.11%	0.39%	0.15%	0.00%
	Extreme	2	3	6	3	0	11	1	9	7
		0.46%	0.43%	0.61%	0.22%	0.00%	0.41%	0.04%	0.44%	0.34%
	Severe	13	28	28	27	27	39	67	53	53
		2.98%	3.99%	2.84%	1.95%	1.45%	1.45%	2.88%	2.60%	2.59%
	Moderate	16	30	56	69	60	92	71	64	82
		3.67%	4.27%	5.68%	4.98%	3.22%	3.41%	3.05%	3.14%	4.01%
	Mild	84	198	301	589	111	385	1073	622	1486
		19.27%	28.21%	30.53%	42.53%	5.96%	14.29%	46.05%	30.52%	72.63%
	Subtotal	117	259	394	690	207	530	1221	751	1628
	%	26.84%	36.90%	39.96%	49.82%	11.11%	19.67%	52.41%	36.85%	79.57%
No injury		182	300	331	485	1182	811	758	543	11
		41.74%	42.74%	33.57%	35.02%	63.51%	30.09%	32.53%	26.64%	0.54%
Near miss		26	78	76	56	36	889	163	567	407
		17.43%	11.11%	7.71%	4.04%	1.93%	32.99%	7.00%	27.82%	19.89%
NA		43	65	106	154	436	465	188	130	30
		13.99%	9.26%	18.76%	11.12%	23.43%	17.25%	8.07%	8.68%	0.00%
Total		**368**	**702**	**907**	**1385**	**1861**	**2695**	**2330**	**1991**	**2076**

Ps. “%” calculated by “individual level/total PSI7”, e.g. %: 2/368=0.46 % in death level on year 2006

5.7.5 The effect of injurious behavior (PSI 8) on patient health

The result of injurious behavior (PSI 8) is shown in **Table 47-49.** The control group (**Table 47**) had no death, extreme or severe injury until 2010. After since, it had only one severe case in year 2011 and 2012. Most of the injury levels fall in the mild injury or no injury group, ranging from 30 to 40% and 33 to 45% respectively. In the experimental group (**Table 48**), the number of injury event is similar to that of the control group. The injury level of death, extreme and severe was zero since 2006 and remain that way until the end of study (2014). The number of events leading to moderate injury showed a significant reduction after 2010, suggesting possible effect from the intervention of SBAR. There were a few events leading to mild injury, however, no significant difference is noted. Most of the injury level fall into the no injury group, approximately 60% of them result in no actual harm. In contrast, the reference group (TPSR system) had approximately 50% of the events leading to actual harm (**Table 49**), with the total number of injurious behavior event increasing from 455 in 2006 to 1964 in 2014. Nearly thirty percent of the events result in mild injury. Approximately 40% of the events result in no injury and 5% result in near miss. At the end of the study, the total number of events caused by injurious behaviors from TPSR report showed a growth of 4.05 times from the baseline.

Table 47 Injury level by injurious behavior (PSI 8) in control group

Ctrl. group		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	0	0	0	0	0	1	1	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	3.33%	0.00%	0.00%

	Moderate	1	1	2	2	4	3	6	5	3
		10.00%	10.00%	20.00%	13.33%	18.18%	15.00%	20.00%	17.24%	14.29%
	Mild	3	3	3	5	7	8	9	9	7
		30.00%	30.00%	30.00%	33.33%	31.82%	40.00%	30.00%	31.03%	33.33%
	Subtotal	4	4	5	7	11	12	16	14	10
	%	40.00%	40.00%	50.00%	46.66%	50.00%	60.00%	53.33%	48.27%	47.62%
No injury		4	4	4	5	10	6	12	13	9
		40.00%	40.00%	40.00%	33.33%	45.45%	30.00%	40.00%	44.83%	42.86%
Near miss		2	2	1	3	0	1	1	1	1
		20.00%	20.00%	10.00%	20.00%	0.00%	5.00%	3.33%	3.45%	4.76%
NA		0	0	0	0	1	1	1	1	1
		0.00%	0.00%	0.00%	0.00%	4.55%	5.00%	3.33%	3.45%	4.76%
Total		**10**	**10**	**10**	**15**	**22**	**20**	**30**	**29**	**21**

Ps. "%" calculated by "individual level/total PSI8", e.g. %: 3/10=30.0 % in mild level on year 2006

Table 48 Injury level by injurious behavior (PSI 8) in experimental group

Exp. group		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Moderate	2	1	2	2	3	0	0	0	0
		33.33%	16.67%	25.00%	16.67%	25.00%	0.00%	0.00%	0.00%	0.00%
	Mild	0	0	1	1	0	1	0	0	1
		0.00%	0.00%	12.50%	8.33%	0.00%	16.67%	0.00%	0.00%	16.67%
	Subtotal	2	1	3	3	3	1	0	0	1
	%	33.33%	16.67%	37.50%	25.00%	25.00%	16.67%	0.00%	0.00%	16.67%
No injury		4	3	5	7	7	4	6	5	4
		66.67%	50.00%	62.50%	58.33%	58.33%	66.67%	85.71%	62.50%	66.67%
Near miss		0	2	0	1	1	1	1	3	1
		0.00%	33.33%	0.00%	8.33%	8.33%	16.67%	14.29%	37.50%	16.67%
NA		0	0	0	1	1	0	0	0	0
		0.00%	0.00%	0.00%	8.33%	8.33%	0.00%	0.00%	0.00%	0.00%
Total		**6**	**6**	**8**	**12**	**12**	**6**	**7**	**8**	**6**

Ps. "%" calculated by "individual level/total PSI8", e.g. %: 2/6=33.3 % in moderate level on year 2006

Table 49 Injury level by injurious behavior (PSI 8) in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	14	21	11	9	29	15	81	61	10
		1.50%	1.46%	0.66%	0.38%	0.90%	0.40%	1.94%	1.52%	0.26%
	Extreme	1	3	4	6	7	14	12	14	3
		0.11%	0.21%	0.24%	0.26%	0.22%	0.37%	0.29%	0.35%	0.08%
	Severe	23	34	20	31	78	97	58	76	63
		2.46%	2.37%	1.20%	1.32%	2.42%	2.59%	1.39%	1.89%	1.67%
	Moderate	121	186	243	456	631	704	774	753	591
		12.96%	12.97%	14.57%	19.47%	19.60%	18.82%	18.51%	18.77%	15.63%
	Mild	296	463	546	855	992	1209	1412	1262	1297
		31.69%	32.29%	32.73%	36.51%	30.82%	32.32%	33.76%	31.46%	34.29%
	Subtotal	455	707	824	1,357	1,737	2,039	2,337	2,166	1,964
	%	48.72%	49.30%	49.40%	57.94%	53.96%	54.50%	55.89%	53.99%	51.93%
No injury		415	645	750	855	1371	1457	1575	1642	1590
		44.43%	44.98%	44.96%	36.51%	42.59%	38.95%	37.66%	40.93%	42.04%
Near miss		28	47	33	72	36	109	186	65	94
		3.00%	3.28%	1.98%	3.07%	1.12%	2.91%	4.45%	1.62%	2.49%
NA		36	35	61	58	75	136	84	139	134
		3.85%	2.44%	3.66%	2.48%	2.33%	3.64%	2.01%	3.46%	3.54%
Total		**934**	**1434**	**1668**	**2342**	**3219**	**3741**	**4182**	**4012**	**3782**

Ps. “%” calculated by “individual level/total PSI8”, e.g. %: 14/934=1.50 % in death level on year 2006

5.7.6 The effect of endo-tube incidents (PSI 9) on patient health

The result of endo-tube incidents (PSI 9) is shown in **Table 50-52.** The control group (**Table 50**) had no events resulting in death, extreme and severe injuries since 2006, but after y2010, there is one severe case in each year from 2011 to 2014. The total number of events also showed an increasing trend throughout the study and had more than doubled of the events by 2014. Percentage of no injury events is approximately 30% to 40%. In the experimental group (**Table 51**), the number of injury event is similar to the control group, with no events resulting in death, extreme and severe injury from the beginning to the end of the study. The total number of endo-tube incidents had a reduction after 2010, this was also reflected in the total events leading to moderate and mild injury. Additionally, the percentage of events resulting in no injury showed an increasing trend, suggesting possible effect of SBAR intervention. In contrast, the reference group (TPSR system) showed an increase in the total number of incidents with no significant difference in the percentage (approximately 60%) resulting in actual damage (**Table 52**), which is similar to the control group, suggesting no effective preventive measure was carried out. The percentage of events resulting in no injury was approximately thirty percent and the percentage of events resulting in near miss was about 1% to 2%. At the end of the study, the total number of injury events caused by endo-tube incidents from TPSR report showed a growth of 9.71 times from the baseline..

Table 50 Injury level by endo-tube incidents (PSI 9) in control group

Ctrl. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Severe	0	0	0	0	0	1	1	1	1
	0.00%	0.00%	0.00%	0.00%	0.00%	2.17%	2.27%	2.56%	2.44%
Moderate	5	5	4	9	9	15	15	13	13
	31.25%	33.33%	33.33%	36.00%	32.14%	32.61%	34.09%	33.33%	31.71%
Mild	5	5	3	8	7	13	12	10	11
	31.25%	33.33%	25.00%	32.00%	25.00%	28.26%	27.27%	25.64%	26.83%
Subtotal	10	10	7	17	16	29	28	24	25
%	62.50%	66.66%	58.33%	68.00%	57.14%	63.04%	63.63%	61.53%	60.98%
No injury	6	5	5	7	11	14	14	14	15
	37.50%	33.33%	41.67%	28.00%	39.29%	30.43%	31.82%	35.90%	36.59%
Near miss	0	0	0	0	1	1	1	0	1
	0.00%	0.00%	0.00%	0.00%	3.57%	2.17%	2.27%	0.00%	2.44%
NA	0	0	0	1	0	2	1	1	0
	0.00%	0.00%	0.00%	4.00%	0.00%	4.35%	2.27%	2.56%	0.00%
Total	**16**	**15**	**12**	**25**	**28**	**46**	**44**	**39**	**41**

Ps. "%" calculated by "individual level/total PSI9", e.g. %: 5/16=31.25% in mild level on year 2006

Table 51 Injury level by endo-tube incidents (PSI 9) in experimental group

Exp. group		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Moderate	6	5	6	8	7	2	3	2	2
		33.33%	26.32%	33.33%	29.63%	23.33%	13.33%	21.43%	20.00%	25.00%
	Mild	5	8	5	9	9	1	1	0	1
		27.78%	42.11%	27.78%	33.33%	30.00%	6.67%	7.14%	0.00%	12.50%
	Subtotal	11	13	11	17	16	3	4	2	3
	%	61.11%	68.43%	61.11%	62.96%	53.33%	20.00%	28.57%	20.00%	37.50%
No injury		6	5	6	9	12	11	9	7	5
		33.33%	26.32%	33.33%	33.33%	40.00%	73.33%	64.29%	70.00%	62.50%
Near miss		0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
NA		1	1	1	1	2	1	1	1	0
		5.56%	5.26%	5.56%	3.70%	6.67%	6.67%	7.14%	10.00%	0.00%
Total		**18**	**19**	**18**	**27**	**30**	**15**	**14**	**10**	**8**

Ps. "%" calculated by "individual level/total PSI9", e.g. %: 5/18=27.78 % in mild level on year 2006

Table 52 Injury level by endo-tube incidents (PSI 9) in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	1	5	5	13	17	11	15	21	6
		0.11%	0.20%	0.13%	0.23%	0.21%	0.12%	0.16%	0.21%	0.06%
	Extreme	1	2	2	4	6	9	8	8	8
		0.11%	0.08%	0.05%	0.07%	0.07%	0.10%	0.09%	0.08%	0.08%
	Severe	17	42	35	46	58	65	80	61	57
		1.79%	1.66%	0.93%	1.95%	1.45%	1.37%	1.94%	1.61%	0.59%
	Moderate	321	609	1008	1575	2051	2397	3281	3108	3287
		33.72%	24.12%	26.76%	28.42%	25.01%	25.78%	35.43%	31.08%	34.20%
	Mild	289	590	887	1598	2122	2957	2267	2345	2997
		30.36%	23.37%	23.55%	28.84%	25.88%	31.80%	24.48%	23.45%	31.19%
	Subtotal	629	1248	1937	3236	4254	5439	5651	5543	6355
	%	66.09%	49.43%	51.42%	59.51%	52.62%	59.17%	62.10%	56.43%	66.12%
No injury		331	1180	1513	1882	3326	3345	3168	3543	3182
		34.77%	46.73%	40.16%	33.96%	40.56%	35.98%	34.21%	35.43%	33.11%
Near miss		15	36	56	32	113	41	170	115	3
		1.58%	1.43%	1.49%	0.58%	1.38%	0.44%	1.84%	1.15%	0.03%
NA		15	61	261	329	446	411	171	699	70
		1.58%	2.42%	6.93%	5.94%	5.44%	4.42%	1.85%	6.99%	0.73%
Total		**990**	**2525**	**3767**	**5479**	**8139**	**9236**	**9160**	**9900**	**9610**

Ps. “%” calculated by “individual level/total PSI9”, e.g. %: 1/990=0.11 % in death level on year 2006

5.7.7 The effect of laboratory incidents (PSI12) on patient health

The result of laboratory incidents is shown in **Table 53-55.** The control group (**Table 53**) had no events resulting in death, extreme and severe injuries since 2006. Events resulting in moderate injury occurred after 2010, with only one case per year from 2011 to 2014. The number of mild injury was few, with 1 to 3 events per year. Most of the events in laboratory incidents end up in the no injury and near miss category. Disregarding the few events, a rise in total event number was noted throughout the study. In the experimental group (**Table 54**), the number of injury event is similar to the control group, with no events resulting in death, extreme and severe injury from the beginning to the end of the study. Some events did end up with moderate and mild injury in the experimental group, at most being one event per year. Similar to the control group, most of the laboratory incidents end up in the no injury and near miss category. In contrast, the reference group (TPSR system) showed an increase in the total number of events but have a decreasing trend in the percentage of events resulting in actual harm (**Table 55**). Even though most of the laboratory incidents end up in the no injury and near miss category, a significant percentage of the incidents end up causing moderate and mild injury.The percentage of events resulting in no injury ranges from 22% to 48%, whereas the percentage of events resulting in near miss ranges from 11% to 50%. At the end of the study, the total number of injury events caused by laboratory incidents from TPSR report showed a growth of 20.38 times from the baseline.

Table 53 Injury level by laboratory incidents (PSI 12) in control group

Ctrl. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Extreme	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Severe	0	0	0	0	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Moderate	0	0	0	0	0	1	1	1	1
	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	5.56%	4.76%	4.76%
Mild	1	0	0	1	1	3	1	3	1
	14.29%	0.00%	0.00%	14.29%	8.33%	15.00%	5.56%	14.29%	4.76%
Subtotal	1	0	0	1	1	4	2	4	2
%	14.29%	0.00%	0.00%	14.29%	8.33%	20.00%	11.12%	19.05%	9.52%
No injury	2	2	4	3	4	8	6	6	7
	28.57%	28.57%	44.44%	42.86%	33.33%	40.00%	33.33%	28.57%	33.33%
Near miss	4	5	4	2	6	6	9	10	10
	57.14%	71.43%	44.44%	28.57%	50.00%	30.00%	50.00%	47.62%	47.62%
NA	0	0	1	1	1	2	1	1	2
	0.00%	0.00%	11.11%	14.29%	8.33%	10.00%	5.56%	4.76%	9.52%
Total	**7**	**7**	**9**	**7**	**12**	**20**	**18**	**21**	**21**

Ps. “%” calculated by “individual level/total PSI12”, e.g. %: 1/7=14.29 % in mild level on year 2006

Table 54 Injury level by laboratory incidents (PSI 12) in experimental group

Exp. group		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Moderate	0	0	0	1	0	0	0	1	0
		0.00%	0.00%	0.00%	9.09%	0.00%	0.00%	0.00%	9.09%	0.00%
	Mild	1	0	0	1	1	1	1	1	1
		12.50%	0.00%	0.00%	9.09%	11.11%	11.11%	12.50%	9.09%	12.50%
	Subtotal	1	0	0	2	1	1	1	2	1
	%	12.50%	0.00%	0.00%	18.18%	11.11%	11.11%	12.50%	18.18%	12.50%
No injury		2	3	2	3	3	3	2	4	2
		25.00%	42.86%	33.33%	27.27%	33.33%	33.33%	25.00%	36.36%	25.00%
Near miss		5	4	4	6	5	4	5	4	5
		62.50%	57.14%	66.67%	54.55%	55.56%	44.44%	62.50%	36.36%	62.50%
NA		0	0	0	0	0	1	0	1	0
		0.00%	0.00%	0.00%	0.00%	0.00%	11.11%	0.00%	9.09%	0.00%
Total		**8**	**7**	**6**	**11**	**9**	**9**	**8**	**11**	**8**

Ps. “%” calculated by “individual level/total PSI12”, e.g. %: 1/8=12.50 % in mild level on year 2006

Table 55 Injury level by laboratory incidents (PSI 12) in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	0	1	2	2	2	3	1
		0.00%	0.00%	0.00%	0.05%	0.06%	0.05%	0.05%	0.06%	0.02%
	Extreme	0	0	2	4	3	1	7	6	0
		0.00%	0.00%	0.21%	0.18%	0.09%	0.02%	0.16%	0.13%	0.00%
	Severe	1	5	4	15	17	28	17	34	8
		0.46%	0.67%	0.42%	0.69%	0.50%	0.70%	0.40%	0.72%	0.18%
	Moderate	21	25	24	24	169	278	280	188	45
		9.59%	3.35%	2.50%	1.10%	5.01%	6.92%	6.51%	3.99%	1.01%
	Mild	45	99	99	88	112	226	261	407	744
		20.55%	13.25%	10.31%	4.04%	3.32%	5.63%	6.07%	8.64%	16.67%
	Subtotal	67	129	129	132	303	535	567	638	798
	%	30.59%	17.27%	13.44%	6.06%	8.99%	13.32%	13.18%	13.54%	17.88%
No injury		107	198	327	745	1165	1276	1300	1318	1020
		48.86%	26.51%	34.06%	34.22%	34.57%	31.77%	30.23%	27.97%	22.85%
Near miss		25	385	480	1250	1616	2002	2156	2658	2518
		11.42%	51.54%	50.00%	57.42%	47.95%	49.85%	50.13%	56.40%	56.41%
NA		20	35	24	50	286	203	278	99	128
		9.13%	4.69%	2.50%	2.30%	8.49%	5.05%	6.46%	2.10%	2.87%
Total		**219**	**747**	**960**	**2177**	**3370**	**4016**	**4301**	**4713**	**4464**

Ps. "%" calculated by "individual level/total PSI12", e.g. %: 45/219=20.55 % in mild level on year 2006

5.7.8 The effect of other incidents (PSI 3, 4, 6, 10, 11, 13) on patient health

As the individual number of incident for PSI 3, 4, 6, 10, 11, and 13 was too few to perform an analysis independently, we decided to. combine these indicators into one indicator. We named this as other incidents, which includes surgery-related incidents (PSI 3), blood transfusion incidents (PSI 4), public accidents (PSI 6), unexpected cardiopulmonary arrests (PSI 10), anesthesia incidents (PSI 11) and other incidents (PSI 13). The result is shown in **Table 56-58.** The control group (**Table 56**) showed several incidents resulting in death with a maximum of 3 events in 2011, 2013, and 2014. Several incidents also end up causing extreme injury with one event in 2011 and 2013. Most of the incidents resulting in actual injury fall into the moderate injury category. No injury and near miss category have a fluctuating trend with no obvious pattern noted. Similar finding was noted in the experimental group (**Table 57**). However, the number of events resulting in death, extreme and severe injury was zero with the exception of one event resulting in severe injury at 2009. The number of events resulting in moderate and mild injury varies throughout the study with the total number of events similar to that of control group. As mentioned earlier, the no injury and near miss category have a fluctuating trend with no obvious pattern noted. In contrast, the reference group (TPSR system) had an acute drop in the number of events resulting in actual injury. A decrease from approximately 3000 events annually to approximately 1300 events. (**Table 58**).Different from the control and experimental group, most of the incidents ends up in the no injury and near miss category instead of moderate and mild injury. A logical explanation is not available due to pooling of the data. At the end of the study, the total number of injury events caused all these other incidents from TPSR report showed a growth of 4.97 times from the baseline.

Table 56 Injury level by other incidents (PSI 3, 4, 6, 10, 11, 13) in control group

Ctrl. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	1	1	1	2	1	3	2	3	3
		3.23%	4.55%	4.35%	4.65%	2.17%	4.92%	5.71%	5.26%	5.77%
	Extreme	0	0	0	0	0	1	0	1	0
		0.00%	0.00%	0.00%	0.00%	0.00%	1.64%	0.00%	1.75%	0.00%
	Severe	2	2	3	3	2	5	5	7	5
		6.45%	9.09%	13.04%	6.98%	4.35%	8.20%	14.29%	12.28%	9.62%
	Moderate	10	7	10	18	21	5	1	26	20
		32.26%	31.82%	43.48%	41.86%	45.65%	8.20%	2.86%	45.61%	38.46%
	Mild	0	0	2	3	5	3	3	1	4
		0.00%	0.00%	8.70%	6.98%	10.87%	4.92%	8.57%	1.75%	7.69%
	Subtotal	13	10	16	26	29	17	11	38	32
	%	41.94%	45.46%	69.57%	60.47%	63.04%	27.88%	31.43%	66.65%	61.54%
No injury		3	7	3	1	7	13	6	12	9
		9.68%	31.82%	13.04%	2.33%	15.22%	21.31%	17.14%	21.05%	17.31%
Near miss		13	2	4	16	8	31	17	5	8
		41.94%	9.09%	17.39%	37.21%	17.39%	50.82%	48.57%	8.77%	15.38%
NA		2	3	0	0	2	0	1	2	3
		6.45%	13.64%	0.00%	0.00%	4.35%	0.00%	2.86%	3.51%	5.77%
Total		**31**	**22**	**23**	**43**	**46**	**61**	**35**	**57**	**52**

Ps. "%" calculated by "individual level/total PSI(3, 4, 6, 10, 11, 13)", e.g. %: 1/31=3.23 % in death level on year 2006

Table 57 Injury level by other incidents (PSI 3, 4, 6, 10, 11, 13) in experimental group

Exp. group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Extreme	0	0	0	0	0	0	0	0	0
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Severe	0	0	0	1	0	0	0	0	0
		0.00%	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%	0.00%	0.00%
	Moderate	1	11	16	11	24	26	18	21	19
		16.67%	73.33%	80.00%	64.71%	63.16%	44.07%	35.29%	39.62%	48.72%
	Mild	0	0	0	1	5	26	26	24	18
		0.00%	0.00%	0.00%	5.88%	13.16%	44.07%	50.98%	45.28%	46.15%
	Subtotal	1	11	16	13	29	52	44	45	37
	%	16.67%	73.33%	80.00%	76.47%	76.32%	88.14%	86.27%	84.90%	94.87%
No injury		1	1	1	0	1	0	5	7	0

	16.67%	6.67%	5.00%	0.00%	2.63%	0.00%	9.80%	13.21%	0.00%
Near miss	4	2	2	3	8	6	2	1	1
	66.67%	13.33%	10.00%	17.65%	21.05%	10.17%	3.92%	1.89%	2.56%
NA	0	1	1	1	0	1	0	0	1
	0.00%	6.67%	5.00%	5.88%	0.00%	1.69%	0.00%	0.00%	2.56%
Total	**6**	**15**	**20**	**17**	**38**	**59**	**51**	**53**	**39**

Ps. "%" calculated by "individual level/total PSI(3, 4, 6, 10, 11, 13)", e.g. %: 1/6=16.67 % in moderate level on year 2006

Table 58 Injury level by other incidents (PSI 3, 4, 6, 10, 11, 13) in reference group

TPSR group		2006	2007	2008	2009	2010	2011	2012	2013	2014
Injury	Death	64	68	184	195	225	287	232	215	327
		2.42%	1.39%	2.28%	1.55%	1.65%	1.78%	1.35%	1.66%	2.48%
	Extreme	9	14	18	55	41	48	68	9	20
		0.34%	0.29%	0.22%	0.44%	0.30%	0.30%	0.40%	0.07%	0.15%
	Severe	100	155	236	339	110	191	256	213	171
		3.78%	3.17%	2.93%	2.70%	0.81%	1.19%	1.49%	1.64%	1.30%
	Moderate	1563	1794	1966	1635	1104	1839	910	240	252
		59.03%	36.64%	24.38%	13.01%	8.08%	11.41%	5.30%	1.85%	1.91%
	Mild	168	185	262	803	1865	1602	1561	2324	556
		6.34%	3.78%	3.25%	6.39%	13.65%	9.94%	9.09%	17.94%	4.22%
	Subtotal	1,904	2,216	2,666	3,027	3,345	3,967	3,027	3,001	1,326
	%	71.91%	45.27%	33.06%	24.09%	24.49%	24.62%	17.63%	23.16%	10.06%
No injury		538	610	1072	3465	2531	4958	5052	3059	4399
		20.32%	12.46%	13.29%	27.56%	18.53%	30.76%	29.41%	23.62%	33.38%
Near miss		102	1851	4188	5234	7669	6893	8592	6759	7091
		3.85%	37.81%	51.93%	41.64%	56.14%	42.77%	50.01%	52.19%	53.81%
NA		104	219	139	845	116	300	508	132	363
		3.93%	4.47%	1.72%	6.72%	0.85%	1.86%	2.96%	1.02%	2.75%
Total		**2648**	**4896**	**8065**	**12571**	**13661**	**16118**	**17179**	**12951**	**13179**

Ps. "%" calculated by "individual level/total PSI(3, 4, 6, 10, 11, 13)", e.g. %: 64/2648=2.42 % in death level on year 2006

6. Discussions

6.1 Discussion of study findings

In this section we discuss the findings from our analysis results.

6.1.1 Why did the total patient safety events keep growing in the TPSR annual report

Till the end of this study, the total number of of patient safety events reported to the TPSR system showed an increasing trend. This can be explained by two major changes in the reporting system. First, the total number of hospital joining / reporting to the TPSR system has been increasing from the beginning to the end of the study. Currently in Taiwan, there are 972 hospitals, 1,251 nursing care unit and 200 psychiatric hospitals (total of 1451 units). In 2006, a total of 171 units (including hospital, nursing unit and psychiatric hospital) were reporting to the TPSR, and by 2014, the reporting hospitals were 376 hospitals in TPSR system, with a reporting rate of 38.7% in all hospitals, and the reporting rate for non hospital caring units (included nursing care units and psychiatric hospitals) were 286, only 19.7% of the units reported to TPSR. Both hospital and non-hospital caring units should be encouraged to report to TPSR. The other reason for the increase in reported events was due to promotion of information disclosure of patient safety incidents in hospital accreditation. According to the accreditation regulation of Taiwan Joint Commission on Hospital Accreditation (TJCHA), the outcome of patient safety was committed to be a key indicator to health care quality in hospital. Since 2003, TJCHA have been continuously encouraging all the hospital in Taiwan to report to TPSR. The reporting of patient safety events became the duty of medical team and hospital administration staff. This policy set by TJCHA aims to prevent injury, encourage patient safety in hospital, and to promote health caring quality. Therefore, based on the above mentioned condition, it is not surprise to find and increase filing of reports in patient safety events by hospitals. We suggest that useful strategies for preventing PSI includes information disclosure, report incentive, definitive handoff system, through education and patient involvement.

6.1.2 The reason SBAR handoff system was used to promote patient safety

In healthcare environment, a significant percentage of errors can be attributed to communication breakdowns and lack of effective teamwork. Communication failures have been identified by the Joint commission of American as the primary root cause in more than 70% of serious events from 1995 to 2003. Communication breakdowns and teamwork failures have been identified as the key contributing factors in the occurrence of patient safety incidents. Therefore, an effective method to reduce the incidents during caring process via communication skills became a critical issue for hospital management and accreditation. While healthcare workers are typically assigned to work in teams to provide and manage patient care, they are generally not well-trained in the generic or non-technical skills (such as communication, situational awareness, decision making and teamwork). Lack of generic or non-technical skills may lead to patient safety incidents and medical errors. This was supported by the findings and verified by the statistical analysis (student t-test and GEE) we presented in **section 5.2**. In the experimental group that adapted SBAR protocol in its handoff system, the total number of events in patient safety incident showed a significant decline when compare to the hospital without SBAR implementation. From the outcome of patient health analysis and the analysis in the level of injuries, one can see that the experimental group generally showed a better performance when compared to the control and reference group. The findings via SBAR application in the experimental group were concluded below:

- Change of patient safety culture: the culture of patient safety in the experimental hospital was changed through SBAR tool. 1) A shared belief that healthcare is a high-risk occupation, 2) A commitment to detect and analyze patient injuries and near misses, and 3) Provide an environment to encourage filing reports of patient safety events and to take disciplinary actions if needed.
- Change of communication within team member: the SBAR tool was used in conjunction with the collaborative communication model. Empowering nurses, physicians, and staff to be proactive in communication and collaboration, aiming to carry out a better practice and finally, improve patient safety.
- Changing the quality of clinical management: while being involved in SBAR intervention, the medical team showed an improvement in efficiency and quality of information exchange during handoff. It also provided a powerful communication setting and collaboration strategies to the health care providers; further facilitate improvements in working environment, communication at the nurse-to-nurse and physician-to-nurse levels, teamwork/collaboration, satisfaction, and patient safety and outcomes.

SBAR is a structured communication technique to standardize communication between two or more people. Due to the potential advantages, SBAR became an effective tool in the handoff system within medical team for promoting patient health.

6.1.3 The effectiveness of SBAR intervention on patient safety

According to our result shown in **Table 17**, the handoff system in the experimental group used SBAR protocol during handoff. We compared the difference between experimental and control groups in different phase (Aim 1 to Aim 4). We found no significant difference within both groups before and during the implementation of SBAR (Aim 1 and 2), suggesting no significant change in patient safety events was present during that period. We hypothesize that the absence of significant change in 2010 (initializing year) between control and experimental group was due to the deferred effect of patient safety by SBAR implementation. Patient safety is the outcome of caring process, so if we want to investigate the effect of SBAR protocol intervention, the effect will be reflected in the next or coming years. This hypothesis was supported by the statistical analysis. After three and five years of SBAR implementation (year 2012 and 2014), a significant difference in patient safety events was noted between the control and experimental group (Aim 3 and 4). The hospital in the control and experimental group has a similar scale on its medical service, medical staff, clinical department and administration system. The only difference was the adaptation of SBAR protocol in the handoff system in the experimental group from 2010. If we look into the change of PSI from the baseline of the experimental group (Aim 5 to 7), a statistical significant difference was noted between 2009 and 2014. This result verified the effectiveness of SBAR disregarding the number of patient safety events increasing yearly. As mentioned earlier, many medical staffs including clinicians, nurses, pharmacists, technicians and administrators was encouraged to report to the TPSR in the circumstance of an incident. Similarly, there was also an increase in the total events within the control group (Aim 5A to 7A), from the baseline, moreover, showed a statistical significant difference when analyzed by pair t-test. These results confirm the effectiveness of SBAR protocol on communication within team member to provide a better caring quality on patient health. SBAR was showed to bridge the differences in interdisciplinary communication and ensure that critical information is delivered consistently. In facilitating stronger communication, SBAR promotes a focus on teamwork rather than individual expertise to overcome avoidable medical errors.

6.1.4 The reason for drug, falling and endo-tube incidents being the top threes

In this study we found the top three incidents were drug-related incidents, falling incidents and endo-tube incidents in control, experimental, and reference group, the results are shown in **Table 24-26**. We here provide a hypothesis for this phenomenon. While analyzing the control and experimental group, drug-related incidents were most often iatrogenic; mainly due to drug delivery and drug dispensation errors. Therefore, training and educate to pharmacists via tools like SBAR are important and valuable for reducing this kind of errors. The second common incident was the falling incidents in hospitals; the occurrence ratio in 2014 was 19.67% (**Table 24**), 10.77% (**Table 25**) and 20.36% (**Table 26**) in control group, experimental group and reference group, respectively. Generally these incidents were caused by unsteady gait and use of sedative medication. Improvement of personnel training and implementation of standard audit procedures for drug delivery and dispensation are the keys to prevent this type of incident.

When compared to the control and reference group, the rate of falling incident in experimental group (with SBAR implementation) was lower than other groups, however, even with implementation of SBAR protocol human negligence errors cannot be avoided. The death rate as a result of falling incident was 0.08 % from TPSR annual report (**Table 40**), the injury rate as a result of falling incidents was approximately 49.5% (49.48%). The data suggests that more can be done to avoid falling incidents, and both the patient and medical team should be actively involved. Lastly, the endo-tube incidents, an incident frequently lead to a fatal outcome in patient safety. From the result showed in **Table 51**, the injury rate in 2014 was 66.12 %, including a death rate of 0.06%, extreme injury level of 0.08%, severe injury level of 0.59%, moderate injury level of 34.2% and mild injury level of 31.19%, the harm induced on patient safety is evident. **Table 50** showed the result of experimental group, the harm caused by endo-tube incidents was lower than that of the control group in both the number of events and percentage of events resulting in actual injury since 2010. The standardized handoff system within medical team was the key for reducing this incident from human errors. A good handoff system allows each and every medical member to review their work and responsibility during the caring process, limiting human errors and promote patient health. In the endo-tube incidents, the major culprit was iatrogenic negligence and failure to carry out standard operating procedures; therefore, enhancing patient safety culture via education system was an effective method to avoid this kind of errors or negligence.

6.1.5 How to improve the caring quality by SBAR protocol

The outcome of patient health was analyzed with the results shown in **Table 32-34**. The outcome of caring quality in the experimental group (**Table 33**) showed that 40.77% of the total event result in actual injury at the end of the study. When compared to the control (38.36%) and the reference group (34.50%), the experimental group showed a higher percentage of inducing actual harm form events. However, despite the higher percentage than the control and reference group, the level of harm in the experimental group mainly falls in the category of moderate (20%) and mild (20%) injury with no death and extreme events. The data suggests that the caring quality in avoiding serious injury is better than that of the control and reference group. In control group (**Table 32**) and reference group (**Table 34**) there were 3 and 371 events of death in 2014. This harm could be prevented by a good management system such as quality assurance system, accreditation system, education system, and handoff system. In this study we adapted the SBAR protocol as an intervention study in the experimental group. The effect on patient safety event and injury prevention was significant, and we can conclude the following:

- The SBAR tool was designed primarily for physician-nurse communications in high urgency situations; both clinical and non-clinical staffs were educated to use and apply SBAR tool, making the quality management process universally relevant within an interdisciplinary caring team.
- The adapted SBAR tool was effectively used in a variety of patient care situations, most notably in the discussions regarding changes in the patient care plan, the situation included both urgent (e.g. changes in patient status) and non-urgent situations (e.g. team debriefing following a challenging admission), discharge planning, as a debriefing tool, and for conflict resolution.
- The effectiveness of SBAR use appeared promising, particularly within the experimental team's perceptions in team communication and patient safety culture. The culture of team work on patient care and patient safety prevention was changed by application of SBAR.

- With targeted use of the SBAR, evaluation of its effectiveness may be more specific and show more change across other domains (e.g. teamwork across teams and handoffs and transitions).

6.1.6 Timing of the incident during SBAR implementation

By analyzing the incidents by timing in the experimental hospital, we found that drug-related incidents usually occurred between 8 and 10 am. Falls and endo-tube incidents usually occurred between 4 and 6 am. The most common location of these incidents was in the wards, followed by intensive care unit and pharmacies. If we analyzed the reporting of incidents by occupation, nurses filed the highest number of incidents, followed by pharmacists and administrative staffs. The chance of physician filing the report for incidents was low. A plan to disclose the information on patient safety for gaining a more safety environment is a critical issue in hospital administration. The hospitals need to be assisted in establishing an internal report and incentive system in the case of patient safety incidents. Hospitals also need to provide a protection mechanism to allow staff members to report incidents without experiencing the fear of punishment. By identifying the root causes of these incidents and sharing the lessons learned across the hospitals is one of the effective way such incidents can be avoided.

6.2 Comparison with previous studies

The analysis of patient safety events was showed in **section 5.1**, the finding was similar to the research published by Lin et al, 2012. By analyzing the 13 types of incident between control and experimental group, we found that the most common types of incidents were drug-related incidents, falling incidents, and endo-tube incidents; this result is consistent with

Lin et al, 2012. Regarding the effectiveness of adapting SBAR protocol in handoff system, our data showed a significant difference before and after application of SBAR between control and experimental group (**Table 17**). The result was most evident after three and five years application of SBAR. This finding was consistent with the study performed by Compton et al, 2012. Furthermore, we suggest an existence of re-enforcing effect when SBAR implementation was long enough to induce a change in the culture of patient safety and the barrier of communication within medical teams. This study also analyzed the events of patient safety (**Table 24**). We identified the top three events from experimental group being the drug-realted incident, falling incidents and endo-tube incidents. The number of incidents in these indicators declined after implementation of SBAR. This finding was partially consistent with the finding of McDonald et al, 2002. In addition, we studied the effect of PSI on patient injury; the finding was shown in **Table 33**. With the intervention of SBAR used in handoff system, the outcome of patient caring quality was significantly better than the control group, with most of incidents resulting in a moderate (20%) and mild (20%) injury, with a few resulting in severe injury of patient health. The result further support the effectiveness of SBAR protocol implementation in patient safety. This finding is partially consistent with the result of Dunsford et al, 2016 and Randmaa et al, 2014. The result of individual PSI on the outcome of patient healthwas shown in **section 5.6**. The finding in experimental group fails to identify a significant difference in the degree of harm before and after implementation of SBAR in individual PSI. Albeit a conclusion cannot be reached, the association between PSI and the outcome of patient caring quality was correlative, and this finding was consistent with the study performed by Rivard et al, 2008.

6.3 Implication of study results

The aims of this study was to evaluate the effectiveness of SBAR protocol in handoff system, the patient safety indicators were used as the outcome marker to investigate caring quality and to confirm the effectiveness of SBAR intervention. The results presented are due to the contribution of physicians, nurses, pharmacists, technicians, administrators, patient and patient family. Therefore, proper team collaboration, training and education is the key to achieve the final goal of enhancingpatient safety. From this study, we have shown the effectiveness of SBAR protocol in handoff system; however, many challenges exists in teamwork training (e.g from culture of working environment, leadership, organization commitment, hospital accreditation, and the awareness of working staff). We therefore suggest the following to be included during future implication of SBAR protocol.

- Teamwork training could include scenarios that challenge clinicians to determine how and what to report. Multisite team training programs should be included.
- Additional research is required to investigate the effect of team training in error frequency, reporting and disclosure skills, especially among team member; The method to file the report is associated to different outcomes when disclosing the information to patients and families (e.g Web-based reporting systems shortens the time used for reporting via data entry, time from incident to report, time to systems improvement, as well as allowing a classification of systems for improvement strategies and the effect of

strategies on error outcomes).

- Although the number of incidents reported has increased significantly by the year, the proportion of incidents that are reported is still too low. The main reason for this is due to the consequence that medical staff may reveive severe punishment under Taiwan's laws if their carelessness is found to have caused such incidents. Thus, hospital personnel may under report patient safety incidents due to the fear of being punished. So to encourage the filing of report by medical staff without being punished is a critical but yet unsolved issue to avoid under-reporting of patient safety events.
- Assisting medical team including nurses, physicians, pharmacists, and technicians etc. to change their current practice of handoff communication could be difficult. However, findings from this study suggests the use of adapted SBAR tool is helpful in both individual and team communications, ultimately affecting perceived changes in the safety culture of medical team. This change in communication requires time to incubate and develop in team work; an immediate effect on the outcome of patient safety is unlikely.
- Allows the management teams to facilitate improvements in working environment, enhance communication at the nurse-to-nurse and physician-to-nurse levels, promoting teamwork/collaboration, satisfaction, and ultimately a better patient safety and outcomes.

6.4 The limitation of PSI on evaluating the patient safety by TPSR system

In this study, we used the indicators of patient safety from TPSR system; these indicators revealed the adverse events induced by patient safety incidents. RCA were then used to clarify the injury level caused by the patient safety event. Data for these indicators was extracted from the TPSR dataset rather than from the hospital directly. This limited the analysis on clinical outcome such as mortality, morbidity and infection rate, we cannot perform further investigation by the available data. However the consistence of PSI's data is an advantage for comparing the quality of patient care within hospitals. Additionally, the injury degree caused by patient safety events was been determined by vaeious RCA team, a bias cannot be excluded as we fail to retrieve the original files from the RCA team due to confidentiality issue. The above mentioned concluded most of the limitations in this study as the PSI indicators used was from a secondary database.

6.5 Future research direction

Many of the finding in this study fails to achieve a definite conclusion and there are many potential studies to be completed. We provide probable directions and suggestion for applying of SBAR in the study of patient safety as following

- **Satisfaction survey during the period of SBAR implementation:** Gaps do exist in this study, we don't know the satisfaction of medical staffs including nurse, physicians, pharmacists, technicians, administrators, supporting staffs, patients, and patient families etc., during the period of SBAR implementation. To observe the effect of SBAR requires a long time to observe the change in the outcome; so a longitudinal study on the change in satisfaction within team member is necessary. Here we suggest the Safety Attitudes Questionnaire (SAQ), it is an easy approach to use for studying the perception from frontline workers during the phase of SBAR implementation. The SAQ can be summarized into six dimensions that are perceptions of management (unit or hospital), safety climate, teamwork climate, working conditions, stress cognition and job satisfaction. By using this tool, we can correlate the attitude of team member with the occurrence of patient safety event, and to analyze the causes and their solutions for promoting care quality.

- **Improving patient safety culture in health care system:** A change in the culture to blame one individual need to be changed, as errors / unfortunate event should be treated as opportunities to improve the system and prevent harm. To study the effectiveness of incentive for reporting patient safety events, using incentive system to replace the blame and punishment, the change of patient safety culture needs to be encouraged on basis of policy and strategy. Future work can investigate on the determination of an effective incentive design that can assist in the increase of reporting PSI across different departments, allow further prevention and reduction of the potential patient safety incidents.
- **SBAR assessment on quality of care**: Future research will have to address the following, including the need for refresher education within team members after initial SBAR education; the need for formal physician to be educated about SBAR use, and the possibility of conducting annual competency validation of the utilization of

SBAR. Research should also examine the effect of SBAR on quality of care and patient outcomes in controlled trials.

- **To evaluate the performance by SBAR intervention in a large hospital:** a large hospital like a medical center or teaching hospital will face different challenge in the management system in clinical care and quality assurance. In our study, the intervention was performed in a metropolitan hospital, application of the SBAR tool in a medical center will provide invaluable data. The effectiveness of SBAR may be more significant when used in a larger hospital.

7. Conclusion

In this study, we have verified the intervention of SBAR protocol implemented in the handoff system by medical team member. Even though the total PSE showed an increasing trend over the study peroid, the intervention still lead to a significant reduction in PSE when compared to the control group. Several years after the implementation of SBAR protocol in the experimental group, the effectiveness of SBAR on PSE became more evident, showing a significant difference from that of control group where SBAR was not applied. In general, the disclosure of PSE in Taiwan's hospital became more transparent due to the accreditation of TJCHA; therefore the increase of reported incidents yearly from the hospital is a normal phenomenon. We used student t-test and GEE to verify the effectiveness of SBAR on PSE and patient injury effects. Both the student t-test and GEE showed that with the intervention of SBAR in handoff system, there is a significant decrease on PSE in the experimental group, and the harm level was also less when compared to the control group. Furthermore, in the analysis of the individual PSI, the drug-related incidents, falling incidents and endo-tube incidents showed a declining trend after SBAR implementation.

Commonly, the implement of SBAR in the experimental group will led to a significant improvement in patient safety. In the study, we analyzed the individual PSI caused by communication errors only and the result did not showed much significance. However, the SBAR did reduce the PSE in volume and on the level of injury in the experimental group. We also found that the number of incidents resulting in actual critical injures such as severe, extreme, and death in the experimental group was obviously fewer and less than the control hospital. Based on our finding, this intervention obviously improved patient safety and health.

During the process of SBAR implementation, we found four additional primary impacts that SBAR brought other than enhanced communication; it facilitated collaborative development within team groups across departments, accurate information exchange, saving the manpower in teamwork and caring cost.

Finally, according to our finding in effectiveness analysis, the culture of patient safetyrequires time to development and adapt. Changing communication processes was a re-learning process and this is the reason for SBAR intervention only to show a significant effect in the experimental group three and five years after its implementation. This also provides an explanation for the absence of significant difference during SBAR implementation. SBAR requires the awareness of staffs, a change of working habit etc. and all of these requires an adaption time to formulate a streamline culture between individual vs individual, system vs system, and individual vs system. Empowering nurses, physicians, and staff to be proactive in communication and collaboration, aiming to carry out a better practice and finally, improve patient safety is critical. A good team collaboration, use of standardized communication tool and providing a continuous education and training course to the management and clinical care system are all critical to achieve a better patient health care environment.

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